N00164.AR.002534
NSA CRANE
5090.3a

SAMPLING AND ANALYSIS PLAN FOR RCRA FACILITY INVESTIGATION REPORT SOLID WASTE MANAGEMENT UNIT 32 (SWMU 32) FORMER FUEL OIL TANK FARM NSA CRANE IN

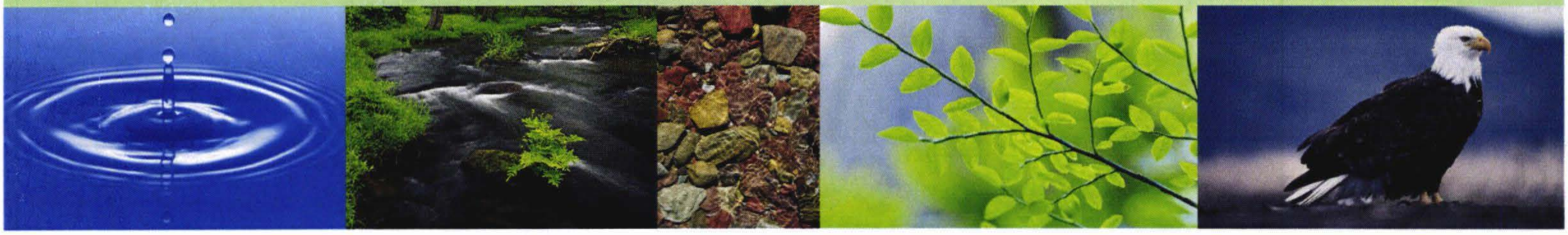
1/1/2010

TETRA TECH

225

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62470-08-D-1001



Sampling and Analysis Plan

for
Phase 1 Resource Conservation and Recovery Act Facility Investigation

for
SWMU 32 – Former Fuel Oil Tank Farm

at
Naval Support Activity Crane, Indiana

Contract Task Order F273

January 2010

NAVFAC
Naval Facilities Engineering Command
Midwest
201 Decatur Avenue
Building 1A, Code EV
Great Lakes, Illinois 60088

TETRA TECH NUS, Inc.

SAP Worksheet No. 1 -- Title and Approval Page

(UFP-QAPP Manual Section 2.1)

DRAFT-FINAL

SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)
January 2010

PHASE I RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION

SWMU 32 – FORMER FUEL OIL TANK FARM
NAVAL SUPPORT ACTIVITY
CRANE, INDIANA

Prepared for:
Naval Facilities Engineering Command Midwest
201 Decatur Avenue, Building 1A
Great Lakes, Illinois 60088

Prepared by:
Tetra Tech NUS, Inc.
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406
610-491-9688

Prepared under:
Contract No. N62470-08-D-1001
Contract Task Order F273

Review Signatures:

Tom Johnston, PhD/CLEAN QAM/Date
Tetra Tech NUS, Inc.

Anthony P. Klimek, P.E./Project Manager/Date
Tetra Tech NUS, Inc.

Approval Signatures:

Thomas J. Brent/RPM/Date
NSA Crane Environmental Restoration Site Manager

Doug Griffin/RPM/Date
Indiana Department of Environmental Management

Government Chemist/Date
NAVFAC QA Review

This page intentionally left blank.

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) has prepared this Sampling and Analysis Plan (SAP) for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 32 – Former Fuel Oil Tank Farm at Naval Support Activity (NSA) Crane, Indiana under Contract Task Order (CTO) F273, Contract No. N62470-08-D-1001, Comprehensive Long-Term Environmental Action Navy (CLEAN). Figure 10-1 shows the locations of the NSA Crane facility and SWMU 32 within the facility.

The Former Fuel Oil Tank Farm (site) operated from 1947 to 1996 as an on-site bulk storage facility for fuel oil to heat buildings located on NSA Crane property. The site included multiple above ground storage tanks that were generally located within concrete walls that formed containment cells. In 1987, approximately 3,700 gallons of virgin Fuel Oil No. 2 was released from the site, and an unknown quantity of the oil discharged to the ditch south of the site and flowed into Culpepper Branch and then into First Creek. The release impacted approximately 300 feet of Culpepper Branch and approximately 4.8 miles of First Creek. The remaining fuel oil presumably soaked into the ground at one of the containment cells (Cell 6) over an approximately 5,000-square-foot area (65 feet by 70 feet).

The fuel oil tanks and associated piping and structures were removed between 1977 and 1999 due to decreased use of fuel oil at the facility. Multiple environmental investigations, removal and demolition projects, and soil excavation projects were performed at SWMU 32 between 1989 and 1999.

The primary purpose of the Phase I RFI described in this SAP is to determine the nature and extent of potential contaminants associated with the site. This information will be used in the remedial decision process. The Phase I RFI will include the collection and analysis of surface and subsurface soil, sediment, and groundwater samples. These samples will be collected to provide representative coverage of the site for use in human health and ecological risk screening and potentially for risk assessment in a follow-up phase, if necessary.

Surface and subsurface soil, sediment, and groundwater samples will be analyzed for fuel oil petroleum chemicals of concern, as defined by the Indiana Department of Environmental Management (IDEM) in the Risk Integrated System of Closure (RISC) Guidance document (IDEM, 2001). Sediment samples will also be analyzed for total organic carbon (TOC) to support site-specific risk calculations. Subsurface soil sample depths will be selected based on direct (visual or olfactory) evidence of contamination or maximum flame ionization detector (FID) screening responses.

Previous investigations and actions, including a 1989 investigation, a 1993 Site Remediation Study, and various removal and remedial activities between 1997 and 1999 are the basis for development of this SAP, which was generated for and complies with applicable Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), IDEM, and United States Environmental Protection Agency (USEPA) Region 5 requirements, regulations, guidance, and technical standards, as appropriate.

This SAP outlines the organization, project management, objectives, planned activities, and measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigations at SWMU 32. Protocols for sample collection, handling, and storage, chain of custody, laboratory and field analyses, data validation, and reporting are also addressed in this SAP. The investigation procedures utilized will comply with the site-specific field Standard Operating Procedures (SOPs), which are included in Appendix A. The laboratory analytical procedures utilized will comply with the laboratory SOPs, which are included in Appendix B. The field work and sampling are scheduled to begin in early 2010. A complete schedule is provided in SAP Worksheet No. 16.

The field activities conducted under this SAP will meet the requirements of the NSA Crane Site-Specific Health and Safety Plan (Tetra Tech, 2008).

SAP Worksheets

List of Figures

Appendices

Acronyms

°C	degrees Celsius
AST	aboveground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CCC	Calibration Check Compound
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
COC	Contaminant of Concern
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
CTO	Contract Task Order
CWAP	Comprehensive Work Approval Process
%D	percent difference or percent drift
DAF	Dilution Attenuation Factor
DCL	Default Closure Level
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DVM	Data Validation Manager
Eco SSL	Ecological Soil Screening Level
Empirical	Empirical Laboratories, LLC
ERA	Ecological Risk Assessment
ERSM	Environmental Restoration Site Manager
ESL	Ecological Screening Level
FD	Field Duplicate
FID	flame ionization detector
FOL	Field Operations Leader
FTMR	Field Task Modification Request

Acronyms
(Continued)

g	gram
GC/MS	gas chromatograph/mass spectrometer
GPS	global positioning system
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HDOP	horizontal dilution of precision
HHRA	Human Health Risk Assessment
HSM	Health and Safety Manager
ICAL	Initial Calibration
ICV	Initial Calibration Verification
IDEM	Indiana Department of Environmental Management
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
IS	Internal Standard
IUPPS	Indiana Underground Plant Protection Services
L	liter
LBGR	lower bound of the gray region
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LUC	land use control
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
mg/L	milligram per liter
mg/kg	milligram per kilogram
mL	milliliter
MPC	Measurement Performance Criterion
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MTBE	methyl tertiary butyl ether
NAVFAC	Naval Facilities Engineering Command
NDIR	non-dispersive infrared
NFA	No Further Action
NFESC	Naval Facilities Engineering Service Center

Acronyms
(Continued)

NOAA	National Oceanic and Atmospheric Administration
NSA	Naval Support Activity
NTU	nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
oz	ounce
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDF	Portable Document Format
PM	Project Manager
PPE	personal protective equipment
ppm	part per million
PQLG	Project Quantitation Limit Goal
PQO	project quality objective
PSL	Project Screening Level
PT	Proficiency Test
QA	quality assurance
QAM	Quality Assurance Manager
QC	quality control
QL	Quantitation Limit
QSM	Quality Systems Manual
%R	percent recovery
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFI	Resource Conservation and Recovery Act Facility Investigation
RI	Remedial Investigation
RISC	Risk Integrated System of Closure
RPD	Relative Percent Difference
RPM	Remedial Project Manager
% RSD	Relative Standard Deviation
RSL	Regional Screening Level
R-RSL	Residential Regional Screening Level
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SDG	sample delivery group
SIM	Selected Ion Monitoring
SMC	System Monitoring Compound
SOP	Standard Operating Procedure

Acronyms
(Continued)

SPCC	System Performance Check Compound
SQL	Structured Query Language
SSL	Soil Screening Level
SSO	Site Safety Officer
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbon
T-RSL	Tapwater Regional Screening Level
Tetra Tech	Tetra Tech NUS, Inc.
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
UFP-SAP	Uniform Federal Policy for Sampling Analysis Plan
µg/kg	microgram per kilogram
µg/L	microgram per liter
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
VSP	Visual Sample Plan

SAP Worksheet No. 2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number:	Naval Support Activity (NSA) Crane
Operable Units:	Solid Waste Management Unit (SWMU) 32
Contractor Name:	Tetra Tech NUS, Inc. (Tetra Tech)
Contract Number:	N62470-08-D-1001
Contract Title:	Comprehensive Long-Term Environmental Action Navy (CLEAN)
Work Assignment Number:	Contract Task Order (CTO) F273

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the Intergovernmental Data Quality Task Force (IDQTF) document, *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (IDQTF, 2005) and the United States Environmental Protection Agency (USEPA) document, *Guidance for Quality Assurance Project Plans*, (USEPA QA/G-5), (USEPA, 2002a).

2. Identify regulatory program: The Indiana Department of Environmental Management (IDEM) Hazardous Waste Closure and Corrective Action Programs, which implement and enforce the Resource Conservation and Recovery Act (RCRA), and related state laws and rules.

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Data Quality Objective (DQO) Meeting	July 22, 2009

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Report on the July 14, 1987 Fuel Oil Release	August 1987
Preliminary Fuel Oil Contamination Study	June 1989
Site Remediation Study, Tank Farm	March 1993
Environmental Work Performed, Tank Farm	July 1997
Tank farm Demolition and Cleanup	1999
Environmental Monitoring Report for Tank Farm	September 2000

6. List organizational partners (stakeholders) and connection with lead organization:

United States Environmental Protection Agency (USEPA) Region 5 (regulatory oversight), Naval Facilities Engineering Command (NAVFAC) Midwest (property owner), Tetra Tech (Navy contractor)

7. Lead organization: Indiana Department of Environmental Management (IDEM) (regulatory oversight)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

There are no exclusions.

UFP-QAPP Worksheet No.	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	Not Applicable
2	Table of Contents SAP Identifying Information	Not Applicable
3	Distribution List	Not Applicable
4	Project Personnel Sign-Off Sheet	Not Applicable
Project Organization		
5	Project Organizational Chart	Not Applicable
6	Communication Pathways	Not Applicable
7	Personnel Responsibilities and Qualifications Table	Not Applicable
8	Special Personnel Training Requirements Table	Not Applicable
Project Planning/Problem Definition		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	Not Applicable
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	Not Applicable
11	Site-Specific Project Quality Objectives	Not Applicable
12	Measurement Performance Criteria Table	Not Applicable
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	Not Applicable
14	Summary of Project Tasks	Not Applicable
15	Reference Limits and Evaluation Table	Not Applicable
16	Project Schedule/Timeline Table	Not Applicable
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	Not Applicable
18	Sampling Locations and Methods/SOP Requirements Table Sample Location Map(s)	Not Applicable
19	Analytical Methods/SOP Requirements Table	Not Applicable
20	Field Quality Control Sample Summary Table	Not Applicable
21	Project Sampling SOP References Table Sampling SOPs	Not Applicable
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Not Applicable
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	Not Applicable
24	Analytical Instrument Calibration Table	Not Applicable
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Not Applicable
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	Not Applicable
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	Not Applicable
Quality Control Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	Not Applicable

UFP-QAPP Worksheet No.	Required Information	Crosswalk to Related Information
Data Management Tasks		
29	Project Documents and Records Table	Not Applicable
30	Analytical Services Table Analytical and Data Management SOPs	Not Applicable
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	Not Applicable
32	Assessment Findings and Corrective Action Responses Table	Not Applicable
33	QA Management Reports Table	Not Applicable
D. Data Review		
34	Verification (Step I) Process Table	Not Applicable
35	Validation (Steps IIa and IIb) Process Table	Not Applicable
36	Validation (Steps IIa and IIb) Summary Table	Not Applicable
37	Usability Assessment	Not Applicable

SAP Worksheet No. 3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address	Document Control Number
Howard Hickey	NAVFAC Remedial Project Manager (RPM)	NAVFAC Midwest	847-688-2600 X243	howard.hickey@navy.mil	Not Applicable (NA)
Tom Brent	Environnemental Restoration Site Manager (ERSM)	NSA Crane	812-854-6160	thomas.brent@navy.mil	NA
Bonnie Capito (final cover letter only)	NAVFAC Atlantic Administrative Record Librarian	NAVFAC Atlantic	757-322-4785	bonnie.capito@navy.mil	NA
Peter Ramanaukas	USEPA RPM	USEPA Region 5	312-866-7890	USEPA Region 5 77 West Jackson Blvd. Chicago, Illinois 60604	NA
Doug Griffin	State RPM	IDEM	317-233-2710	dgriffin@idem.in.gov	NA
Tony Klimek	Project Manager (PM)	Tetra Tech	513-557-5057	tony.klimek@tetratech.com	NA
Ralph Basinski	Crane Activity Coordinator	Tetra Tech	412-921-8308	ralph.basinski@tetratech.com	NA
Tom Johnston	Quality Assurance Manager (QAM)	Tetra Tech	412-921-8615	tom.johnston@tetratech.com	NA
Matt Soltis	Health and Safety Manager (HSM)	Tetra Tech	412-921-8912	matt.soltis@tetratech.com	NA
Joe Samchuck	Data Validation Manager (DVM)	Tetra Tech	412-921-8510	joseph.samchuck@tetratech.com	NA
George Ten Eyck	Field Operations Leader (FOL) and Site Safety Officer (SSO)	Tetra Tech	513-557-5043	george.teneyck@tetratech.com	NA
Mark Traxler	Project Chemist and Quality Assurance/Quality Control (QA/QC) Advisor	Tetra Tech	610-382-1171	mark.traxler@tetratech.com	NA
Janice Shilling	Laboratory PM	Empirical Laboratories, LLC (Empirical)	615-345-1115	jshilling@empirlabs.com	NA

SAP Worksheet No. 4 -- Project Personnel Sign-Off Sheet

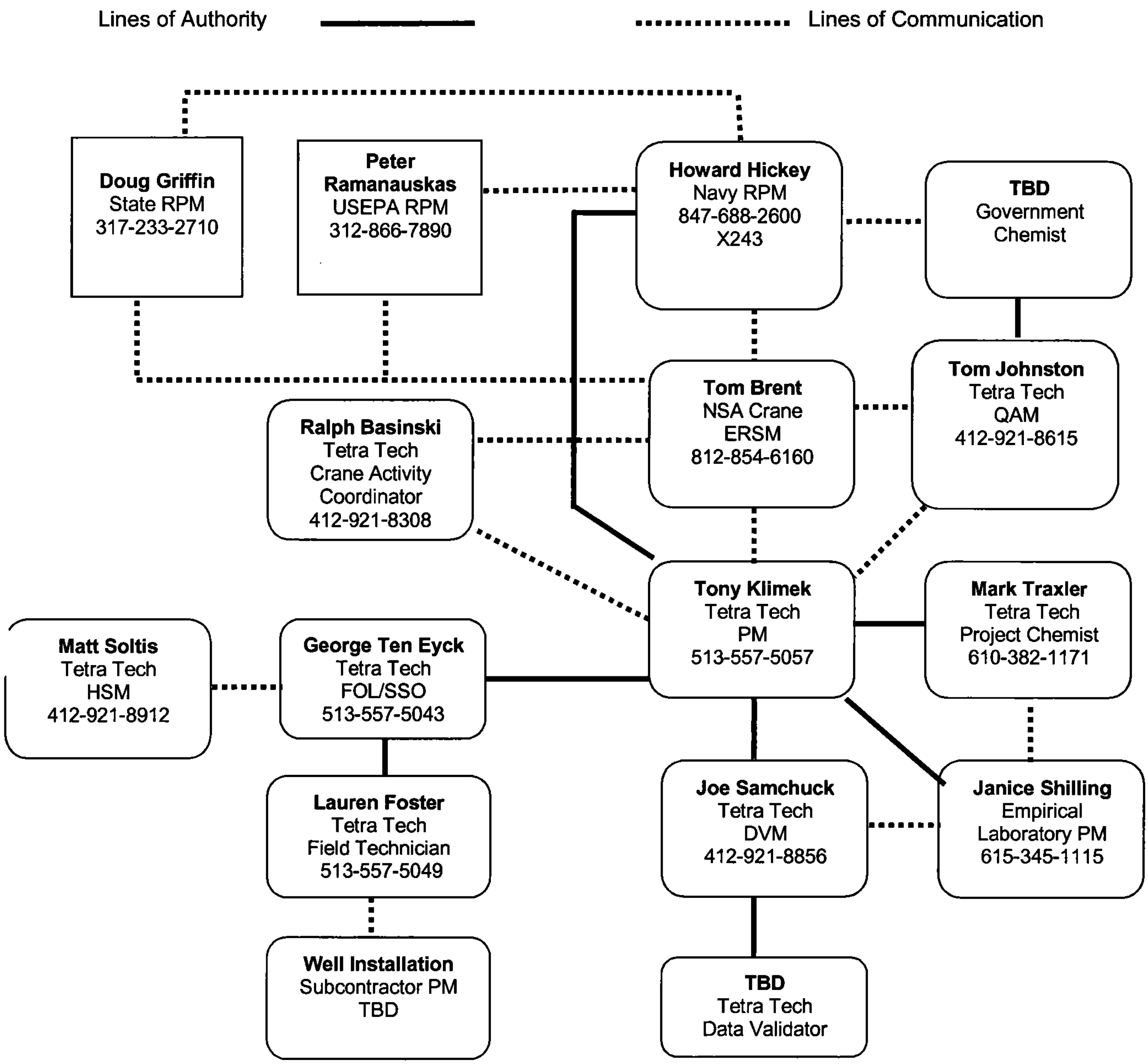
(UFP-QAPP Manual Section 2.3.2)

Name [1]	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
George Ten Eyck	Tetra Tech FOL/SSO	513-557-5043		All	
Joe Samchuck	Tetra Tech DVM	412-921-8510		Worksheet Nos. 12, 14, 15, 19, 20, 23-28, 30, and 34-37	
Mark Traxler	Tetra Tech Project Chemist	610-382-1171		All	
TBD	Well Drilling Subcontractor PM	TBD		Worksheet Nos. 10, 11, 14, and 17	
Janice Shilling	Empirical Laboratory PM	615-345-1115		Worksheet Nos. 12, 14, 15, 19, 20, 23-28, 30, and 34-36	

1 Persons listed in this worksheet will be responsible for distributing the SAP to the appropriate people within their organization.

SAP Worksheet No. 5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)



SAP Worksheet No. 6 -- Communication Pathways
(UFP-QAPP Manual Section 2.4.2)

Communication Driver	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Regulatory Agency Review	State RPM USEPA RPM	Doug Griffin Peter Ramanauskas	317-233-2710 312-866-7890	Review technical documents within the time frame agreed upon by the Project Team.
SAP Amendments	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM	George Ten Eyck Tony Klimek Howard Hickey	513-557-5043 513-557-5057 847-688-2600 x243	Tetra Tech FOL will verbally inform Tetra Tech PM within 24 hours of realizing a need for an amendment. Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within 5 days and send the Navy RPM a concurrence letter within 7 days of identifying the need for change. SAP Amendments will be submitted by Tetra Tech PM to NAVFAC Midwest Program Management Office for review and approval.
Field issues that require changes in field tasks	Tetra Tech FOL/SSO Tetra Tech PM NSA Crane ERSM Navy RPM	George Ten Eyck Tony Klimek Tom Brent Howard Hickey	513-557-5043 513-557-5057 812-854-6160 847-688-2600 x243	Tetra Tech FOL will inform Tetra Tech PM on the day issue is discovered. Tetra Tech PM will inform NSA Crane ERSM and Navy RPM within 2 business days of discovery; Navy RPM will issue scope change approval (verbally or by e-mail) if warranted; scope change to be implemented before work is executed. Tetra Tech PM will document the change via a FTMR form within 2 days of identifying the need for change and obtain required approvals within 5 days of initiating the form.
Changes in field work schedule	Tetra Tech PM NSA Crane ERSM	Tony Klimek Tom Brent	513-557-5057 812-854-6160	Tetra Tech PM will verbally inform the NSA Crane ERSM on the day that a schedule change is known and will document via schedule impact letter within 1 business day of when the impact is realized.

Communication Driver	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Issues in the field that result in changes in scope of field work	Tetra Tech FOL/SSO Tetra Tech PM NSA Crane ERSM Navy RPM	George Ten Eyck Tony Klimek Tom Brent Howard Hickey	513-557-5043 513-557-5057 812-854-6160 847-688-2600 x243	Tetra Tech FOL will inform Tetra Tech PM within 1 business day; Tetra Tech PM will inform NSA Crane ERSM and Navy RPM by close of the next working day; and Navy RPM will issue scope change if warranted; scope change to be implemented before work is executed. Tetra Tech PM will document the changes within 2 days of identifying the need for change on a FTMR form and obtain required approvals within 5 days of initiating the form.
Recommendations to stop work and initiate work upon corrective action	Tetra Tech FOL/SSO Tetra Tech PM Tetra Tech QAM Tetra Tech Project Chemist Tetra Tech HSM NSA Crane ERSM	George Ten Eyck Tony Klimek Tom Johnston Mark Traxler Matt Soltis Tom Brent	513-557-5043 513-557-5057 412-921-8615 610-382-1171 412-921-8912 812-854-6160	If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform onsite personnel, subcontractor(s), NSA Crane ERSM, and the identified Project Team members within 1 hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor PM must inform the Tetra Tech FOL within 30 minutes, and the FOL will then follow the procedure listed above.
Field data quality issues	Tetra Tech FOL/SSO Tetra Tech PM	George Ten Eyck Tony Klimek	513-557-5043 513-557-5057	Tetra Tech FOL will inform Tetra Tech PM verbally or by e-mail on the same day that a field data quality issue is discovered.
Analytical data quality issues	Empirical Laboratory PM Tetra Tech Project Chemist Tetra Tech PM	Janice Shilling Mark Traxler Tony Klimek	615-345-1115 610-382-1171 513-557-5057	Laboratory PM will notify the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is identified. Tetra Tech Project Chemist will notify (verbally or by e-mail) the data validation staff and Tetra Tech PM within 1 business day.

SAP Worksheet No. 7 -- Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Doug Griffin	RPM	IDEM	Participates in scoping, data review, and evaluation and approves the SAP.
Peter Ramanauskas	RPM	USEPA Region 5	Oversees project implementation, including scoping, data review, and evaluation.
Tom Brent	ERSM	NSA Crane	Oversees site activities, participates in scoping, data review, and evaluation, and approves the SAP.
Howard Hickey	RPM	NAVFAC Midwest	Oversees project implementation including scoping, data review, and evaluation.
John Trepanowski	Program Manager	Tetra Tech	Oversees the CLEAN NAVFAC Midwest Program.
Tony Klimek	PM	Tetra Tech	Oversees project, financial, schedule, and technical day to day management of the project, including the following: • Ensures timely resolution of project-related technical, quality, and safety questions associated with Tetra Tech operations. • Functions as the primary Tetra Tech interface with the Navy RPM, NSA Crane ERSM, Tetra Tech field and office personnel, and laboratory points of contact. • Ensures that Tetra Tech health and safety issues related to this project are communicated effectively to all personnel and off-site laboratory(s). • Monitors and evaluates all Tetra Tech subcontractor performance. • Coordinates and oversees work performed by Tetra Tech field and office technical staff (including data validation, data interpretation, and report preparation). • Coordinates and oversees maintenance of all Tetra Tech project records. • Coordinates and oversees review of Tetra Tech project deliverables. • Prepares and issues final Tetra Tech deliverables to the Navy. •
George Ten Eyck	FOL/SSO	Tetra Tech	Supervises, coordinates, and performs field sampling activities, including the following: • Ensures that health and safety requirements are implemented. • Functions as the on-site communications link between field staff members, the NSA Crane ERSM, and Tetra Tech PM. • Alerts off-site analytical laboratory(s) of any special health and safety hazards associated with environmental samples. • Oversees the mobilization and demobilization of all field equipment and subcontractors. • Coordinates and manages the field technical staff. • Adheres to the work schedules provided by the Tetra Tech PM.

Name	Title/Role	Organizational Affiliation	Responsibilities
			• Ensures the proper maintenance of site logbooks, field logbooks, and field recordkeeping. • Initiates FTMRs when necessary. • Identifies and resolves problems in the field, resolving difficulties via consultation with the NSA Crane ERSM, implementing and documenting corrective action procedures, and providing communication between the field team and project management. As SSO, is responsible for training and monitoring site conditions related to personnel safety. Details of the SSO's responsibilities are presented in the HASP and include the following: • Controls specific health and safety-related field operations such as personnel decontamination, monitoring of worker heat or cold stress, and distribution of safety equipment. • Conducts and documents a daily health and safety briefing each day while on site. • Assures that field personnel comply with all procedures established in the HASP. • Identifies an assistant SSO in his absence. • Terminates work if an imminent safety hazard, emergency situation, or other potentially dangerous situation is encountered. • Ensures the availability and condition of health and safety monitoring equipment. • Coordinates with the Tetra Tech PM to institute and document any necessary HASP modifications. • Ensures that facility personnel and subcontractors are adequately advised and kept clear of potentially contaminated materials.
Tom Johnston	QAM	Tetra Tech	Reviews the SAP, oversees preparation of the laboratory scope, coordinates with laboratory(s), and conducts data quality review. Ensures quality aspects of the CLEAN program, including the following: • Develops, maintains, and monitors QA/QC policies and procedures. • Provides training to Tetra Tech staff in QA/QC policies and procedures. • Conducts systems and performance audits to monitor compliance with environmental regulations, contractual requirements, SAP requirements, and corporate policies and procedures. • Audits project records. • Monitors subcontractor quality controls and records. • Assists in the development of corrective action plans and ensuring correction of non-conformances reported in internal or external audits. • Ensures that this SAP meets Tetra Tech, Navy, and IDEM requirements. • Prepares QA reports for management.
Mark Traxler	Project Chemist, QA/QC Advisor	Tetra Tech	Coordinates analyses with laboratory chemists, ensures the scope is followed and that QA has been performed for QA data packages, and communicates with Tetra Tech staff. • Ensures that the project meets objectives from the standpoint of laboratory performance. • Provides technical advice to the Tetra Tech Project Team on project chemistry matters. • Monitors and evaluates subcontractor laboratory performance.

Name	Title/Role	Organizational Affiliation	Responsibilities
			• Ensures timely resolution of laboratory-related technical, quality, or other issues effecting project goals. • Functions as the primary interface with the subcontracted laboratory(s) and Tetra Tech PM. • Coordinates and oversees work performed by the subcontracted laboratory(s). • Oversees the completion of Tetra Tech data validation. • Coordinates and oversees review of laboratory deliverables. • Recommends appropriate laboratory corrective actions. As the Site QA/QC Advisor, will be responsible for ensuring adherence to all QA/QC requirements as defined in this SAP. Strict adherence to these procedures is critical to the collection of acceptable and representative data. The following is a summary of the Site QA/QC Advisor's responsibilities: • Ensuring that field QC samples are collected at the proper frequencies. • Ensuring that additional volumes of sample are supplied to the analytical laboratory(s) at the proper frequency to accommodate laboratory QA/QC analyses. • Ensuring that measuring and test equipment are calibrated, used, and maintained in accordance with applicable procedures and technical standards. • Acting as liaison between site personnel, laboratory personnel, and the QAM. • Managing bottleware shipments and overseeing field preservation. • Preparing a daily log of all work being performed.
Joseph Samchuck	DVM	Tetra Tech	Ensures the QA of data validation deliverables. • Oversees data validation activities. • Serves as a communication link between Tetra Tech and laboratory(s) on data validation and electronic data posting activities. • Establishes Tetra Tech data validation protocols in support of projects.
Matt Soltis	HSM	Tetra Tech	Oversees the CLEAN Program Health and Safety Program • Provides technical advice to the Tetra Tech PM on matters of health and safety. • Oversees the development and review of the HASP. • Conducts health and safety audits. • Prepares health and safety reports for management.
Janice Shilling	Laboratory PM	Empirical	• Ensures that the scope is followed. • Coordinates analyses with laboratory chemists. • Performs QA on data packages. • Communicates with Tetra Tech staff.

In some cases, one person may be designated responsibilities for more than one position. For example, the FOL will be responsible for SSO duties. This action will be performed only as credentials, experience, and availability permits.

SAP Worksheet No. 8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Additionally, each site worker will be required to have completed a 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) course (and 8-hour refresher training, if applicable) in health and safety training as described under Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(b)(4). Safety requirements are addressed in greater detail in the site-specific HASP.

SAP Worksheet No. 9 -- Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

Project Name: NSA Crane SWMU 32 Phase I RCRA Facility Investigation (RFI) Projected Date(s) of Sampling: Early 2010 Project Manager: Tony Klimek			Site Name: SWMU 32 – Former Fuel Oil Tank Farm Site Location: Crane, Indiana		
Date of Session: July 22, 2009 **Scoping Session Purpose:** DQO Meeting					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Tony Klimek	PM	Tetra Tech	513-557-5057	tony.klimek@tetratech.com	Management
Tom Brent	ERSM	NSA Crane	812-854-6160	thomas.brent@navy.mil	Management
Doug Griffin	RPM	IDEM	317-233-2710	dgriffin@idem.in.gov	State RPM
Tom Johnston	QAM	Tetra Tech	412-921-8615	tom.johnston@tetratech.com	QAM
Ralph Basinski	Crane Activity Coordinator	Tetra Tech	412-921-8308	ralph.basinski@tetratech.com	Management/ Oversight
Mark Traxler	Project Chemist	Tetra Tech	610-382-1171	mark.traxler@tetratech.com	Chemist

Comments/Decisions: Discussed SWMU 32 historical use and available data. Discussed the steps for the Phase I RFI in accordance with the UFP-SAP format. Also discussed potential future tasks that could be required, based on the results from the Phase I RFI.

Action Items: Tetra Tech assigned task of preparing draft UFP-SAP.

Consensus Decisions: See meeting minutes in Appendix C. The meeting participants developed project quality objectives (PQOs) using USEPA's seven-step DQO Process. Consensus decisions included the following:

- Limit Phase I activities to a site investigation; potential risk assessments and corrective measures will be addressed in a later phase, if necessary.
- Collect surface and subsurface soil samples from two Decision Units (southern and northern portions of the site, as identified in Worksheet No. 17) to address the former tank farm, and collect limited additional surface and subsurface soil, sediment, and groundwater samples.
    - Three surface and subsurface soil samples in the drainage way of the 1987 Release.
    - One subsurface soil sample in the vicinity of the former gasoline tank (analyze for methyl tertiary butyl ether [MTBE] in addition to fuel oil petroleum COCs, see Section 10.4).
    - Three sediment samples from Culpepper Branch.
- Do not collect any surface water samples in Phase I.
- Analyze collected samples for fuel oil petroleum contaminants of concern, as defined in IDEM regulations and guidance documents.
- If any of the risk screening criteria are exceeded, the Project Team will evaluate the distribution, magnitude, and significance of the exceedance(s) to determine the most appropriate path forward with the ideal goal of clean closure under residential default closure criteria, if possible and cost-effective.
- The Project Team planned for the Phase II RFI in the event it is required. The data collection design and performance criteria to be applied to data collected during the Phase I RFI will support screening-level risk assessments and will assist in developing the Phase II RFI sampling event to further evaluate risk and complete delineation of contamination.

SAP Worksheet No. 10 -- Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

This worksheet presents general background information about SWMU 32 – Former Fuel Oil Tank Farm and a conceptual site model (CSM) that describes potential contamination routes and possible exposure pathways. The CSM served as the basis for developing the sampling and analysis program.

10.1 PHYSICAL SITE DESCRIPTION

SWMU 32 – Former Fuel Oil Tank Farm is located in the northwest area of NSA Crane (see Figure 10-1). It is located just northeast of Highway H-5 as shown on Figure 10-2. The site covers approximately 3 acres and is currently vacant, grass-covered, and open. With the exception of two small areas, a chain-link fence surrounds the site. All previously existing tank farm structures (storage tanks, associated piping, and tank farm containment walls) have been removed and the site has been vacant since 1999.

Most of NSA Crane is forested including the area surrounding the site. The nearest stream, Culpepper Branch, is located approximately 400 feet southwest of the site and south of Highway H-5. As shown on Figure 10-2, Culpepper Branch drains into First Creek approximately 700 feet south of the site. The northern side of the site slopes gently northwest and into a drainage channel that flows through a pipe under Highway H-5 to Culpepper Branch. The southern side of the site flows southeast to a drainage channel that flows through a pipe under Highway H-5 and into Culpepper Branch.

NSA Crane is in the unglaciated Crawford upland physiographic province of southern Indiana, which is a rugged dissected plateau bordered on the west by the Wabash lowland and on the east by the Mitchell plain. Bedrock geology is mapped as Pennsylvanian and Mississippian sandstones, limestones, and shales overlain by Quaternary-age deposits. Groundwater flow in the area generally mimics topography and is assumed to flow south-southwest to Culpepper Branch and First Creek. Depth to groundwater at SWMU 32 is unknown; based on other site investigations in the area, it is expected to be less than 20 feet. Surface soil at the site has been disturbed by the construction of, and subsequent removal and remediation of, the Former Fuel Oil Tank Farm.

The nearest residence is approximately one-half mile southeast of the site. The next nearest residences are approximately 1.5 miles northwest of the site in the Village of Crane, which is located just north of NSA Crane.

The NSA Crane facility was a rural, forested, and farmed area when it was commissioned as a Navy facility in 1941; the site has been part of the Navy facility since that time. There are no known historical or cultural concerns, such as Native American burial grounds or historic landmarks on or in the vicinity of the site. There are no land use controls (LUCs) associated with the site.

10.2 SMWU 32 HISTORY

The Former Fuel Oil Tank Farm was operational from 1947 to 1996 as an on-site bulk storage facility for fuel oil to heat buildings located on NSA Crane property. The locations of the former tanks are shown on Figure 10-3.

The Fuel Oil Tank Farm was constructed in phases from 1947 to 1975. By the 1970s, 19 aboveground storage tanks (ASTs) were on site. Seventeen of these ASTs were contained within six concrete cells (Cell 1 to Cell 6) that were approximately 58 feet wide and 210 feet long. The cells had concrete walls that extended 4 feet underground and were used for secondary containment; there were no concrete or impervious floors in the cells. Fuel oil was delivered by tanker trucks and transferred into the tanks via piping. Fuel oil was loaded from the tanks into tanker trucks for local transport. The fuel loading and unloading area was south and south-southwest of the fuel tank containment area in the region identified on the figure as "Tanker Unloading Station." Fuel piping to and from the tanks was located primarily underground and was bare single-walled steel with no corrosion protection.

Several other tanks were present at the tank farm area. A horizontal AST for waste oil was located within the containment walls, and an underground storage tank (UST) used to store No. 6 Fuel Oil and two smaller ASTs were south of and outside the containment walls. One AST was used to store gasoline, and the other was used to store No. 1 Fuel Oil. Trench drains collected runoff from the site and conveyed it to a sump and then to an underground 3,000-gallon oil/water separator located south of the concrete-walled containment area.

In 1987, approximately 3,700 gallons of virgin Fuel Oil No. 2 was released from the site when a valve on Tank 2634 was inadvertently left open in Cell No. 6 on the southern side of the site. An unknown quantity of the oil discharged to the existing ditch south of the site and flowed southwest through a pipe under Highway H-5 and the railroad tracks, into Culpepper Branch and then into First Creek. This ditch is referred to throughout this document as the "drainage way from the 1987 release". Absorbent booms and pads were used to collect oil from First Creek. Oil was pumped and vacuumed from Cell 6 and First Creek and was flushed from the ditch and culvert leading to Culpepper Branch. Soil was excavated from the ditch between the site and Culpepper Branch. Approximately 500 gallons of fuel oil were collected from Cell 6. The release impacted approximately 300 feet of Culpepper Branch and approximately 4.8 miles of First Creek. The remaining fuel oil presumably soaked into the ground at Cell 6 over an approximately 5,000-square-foot area (65 feet by 70 feet).

The ASTs, USTs, and associated piping and structures were removed between 1977 and 1999 due to decreased use of fuel oil at the facility.

10.3 PREVIOUS ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

Multiple environmental investigations, removal and demolition projects, and soil excavation projects were performed at SWMU 32 between 1989 and 1999.

In 1989, a two-phase investigation was performed to characterize possible soil contamination within the six cells of the Former Fuel Oil Tank Farm. The first phase consisted of a soil gas survey, and the second phase consisted of a soil sampling and analysis program. Samples were collected from areas with elevated soil gas readings. Total petroleum hydrocarbons (TPH) were detected in two soil samples from Cell 6 at concentrations greater than 100 milligrams per kilogram (mg/kg), the then-applicable IDEM action level for TPH in soil. The study recommended that soil be removed for proper disposal from the two locations in Cell 6. The study also recommended removal of soil from six additional locations with a "noticeable presence of petroleum hydrocarbons" but with TPH concentrations less than the action level (ATEC Environmental Consultants, 1989; PEDCo, E and A Services, Inc., 1989).

In 1993, a Site Remediation Study concluded that contamination at the site was more limited than previously thought and confined principally to surficial clay soil. Soil borings and test pits indicated that subsurface contamination was limited to the southern side of the site in Cells 5 and 6. Cell 6 had the greatest concentrations of TPH, with concentrations greater than 100 m/kg detected at depths of 3.5 to 5 feet and 6 feet. The study recommended removal of all soil with TPH concentrations greater than 100 mg/kg and any contaminated groundwater that may exist (Howard, Needles, Tammen, and Bergendoff, 1993).

Between 1997 and 1999, all remaining tanks, piping, and associated concrete structures were removed from the site. In 1997, the seven remaining ASTs (including the waste oil tank) and UST were removed along with most of the associated concrete structures. Prior to removal, the remaining sludge in the waste oil tank was sampled and analyzed. Sampling and analysis during UST removal was performed in accordance with IDEM procedures. A gravel layer was encountered at a depth of approximately 7 feet in Cell 6. It was estimated to be approximately 62 feet long by 58 feet wide and extended beyond the limits of the Cell 6 containment wall. The gravel layer was left in place. Approximately 3,000 cubic yards of fuel-contaminated soil and sand were removed from the site and disposed off site. Clean soil from the northwestern area of the site was used to backfill some of the excavations. Additionally, approximately 2,750 cubic yards of soil were removed, temporarily stockpiled, and returned to the southeastern area of the containment area (Sverdrup Environmental, Inc., 1997a and 1997b).

The final phase of previous environmental work was performed in 1998 and 1999. The Crane Public Works Department plowed soil on the site once every two weeks for six weeks (three plowings) in the area to expose the soil to the air. Three soil samples were collected and analyzed for polychlorinated biphenyls (PCBs) and Toxicity Characteristic Leaching Procedure (TCLP) metals after plowing. No PCBs were detected in the samples. Barium was the only one of the nine TCLP metals detected; it was detected in the TCLP leachate from all three samples at less than 1 milligram per liter (mg/L). The Public Works Department also removed the oil/water separator along with the associated pipelines, which were sold for scrap. Finally, all remaining concrete and other debris were removed from the site. Groundwater was never evaluated in the previously identified investigations. A 1999 Navy memorandum concluded that, "The site is now clean.... No other cleanup activities are planned at this time." (Department of the Navy, 1999).

In September 2000, Science Applications International Corporation (SAIC) issued an Environmental Monitoring Report for the Tank Farm at Crane Division Naval Surface Warfare Center, which summarized previous environmental work at the site including the gravel layer that was encountered in 1987 and left in place and the subsequent excavation and remediation work that did not explicitly address this gravel layer. The report concluded that SWMU 32 "...cannot be considered a clean site." and recommended that additional samples be collected to characterize the site and specifically address the buried gravel layer in Cell 6 (SAIC, 2000). This UFP-SAP describes the work proposed to address that recommendation.

The data collected during previous investigations are not of sufficient quality to evaluate potential human health or ecological risk related to residual impacts at the site because the majority of the reported data were soil gas survey and TPH results. Data gaps exist, and data are more than 10 years old and may not represent current conditions. Additionally, data may be from soil or other material that has been altered, moved, or removed through remediation or construction. Data gaps include the extent of the gravel layer at Cell 6; groundwater depth and potential impact; and the nature and extent of potential contamination in off-site soil, and sediment in the streams downgradient of the site potentially impacted by the 1987 release.

10.4 CONCEPTUAL SITE MODEL

Spills and leaks from tanks and trucks at the Former Fuel Oil Tank Farm are the sources of potential contamination at SWMU 32. These spills and leaks were the result of routine operations and at least one reported release event in 1987. Contamination as a result of routine operations may have occurred throughout the site but is likely limited to certain locations such as areas where transferring and filling occurred. The only documented oil release was the 1987 release from a tank in Cell 6 that discharged approximately 3,700 gallons of Fuel Oil No. 2 onto the soil in Cell 6 (and possibly into Cell 5 based on analytical results), which then flowed into nearby streams.

Based on site operations and the documented historical release, areas of interest include the following (see Figure 10-3):

- Cell 5 Area
- Cell 6 Area
- Tanker Unloading and Tanker Fill Station Area
- Drainage way from the 1987 Release

10.4.1 Potential Sources and Contaminants of Concern

Based on historical and operations information, spills and leaks occurred directly into the soil, with the exception of the 1987 release, which also released fuel oil directly into nearby streams. Because the potential contaminants at this site originate from the use and storage of fuel oil, the project team has agreed to approach the site as a typical UST Site, as defined in the RISC User's Guide (February 15, 2001). The site characterization process for a UST Site is ultimately the same as the RCRA site characterization process; however, four groups of petroleum hydrocarbons have been identified by RISC as the petroleum contaminants of concern (COCs). The target analyte list for this investigation was selected from the list of petroleum COCs and is based on the type of fuel used at the site. The target analyte list includes: naphthalene and the seven Class B2 carcinogenic polycyclic aromatic hydrocarbons (cPAHs) for surface soil; and benzene, toluene, ethylbenzene, total xylenes (BTEX), naphthalene, and the seven Class B2 cPAHs for subsurface soil, sediment, and groundwater. Surface soil will not be investigated for BTEX because these constituents are not likely to be encountered at the surface due to their volatile nature and the length of time since operations ceased at the site.

10.4.2 Potential Migration and Exposure Pathways

After release to the soil, contamination may (1) result in a complete exposure pathway to human and ecological receptors, and/or (2) serve as a source of contamination to groundwater and surface water and result in a complete exposure pathway through those routes. The impacts of contamination reaching a stream may result in direct exposure to receptors in and along the stream. Floating and dissolved oil may also have soaked into stream banks and stream sediments to act as a contaminant reservoir for migration to groundwater and result in direct exposure to contaminated soil. Potential exposure pathways are illustrated on Figure 10-4 and Figure 10-5 for human and ecological receptors, respectively. Figure 10-6 presents a Conceptual Site Model Schematic.

10.4.3 Potential Receptors

Human receptors at SWMU 32 include people who currently, or could in the future, interact with contaminated media. Current site users include industrial or construction workers and trespassers. The area is rural, and there is one identified residence within a mile of the site. However, because future land use is unknown, it is customary to evaluate the future use of a property as residential and recreational. Therefore, potential future receptors include residents and persons recreating at the site. Human receptors may be exposed to different media based on their specific activities. These media include surface and subsurface soil, groundwater, surface water, and sediment.

Ecological receptors include animal and plant species that could be affected by the contaminants that are present at the site. Typically, ecological receptors can be exposed only to surface media – surface soil, surface water, and upper layers of wetland or stream sediment. Exposure of ecological receptors to groundwater and subsurface soil is not anticipated; however, contamination in subsurface soil or groundwater may serve as sources of contamination to sediment or surface water through subsurface transport or diffuse flow to streams. The exposure media for ecological receptors are surface soil, sediment, and surface water. Terrestrial plants, invertebrates, and vertebrates are exposed to surface soil by direct contact and ingestion of soil and other food items. Aquatic and semi-aquatic vegetation, benthic invertebrates, and aquatic organisms are exposed to surface water and sediment by direct contact and/or ingestion of sediment and surface water and other food items. Benthic invertebrates or other aquatic organisms that may have contacted or ingested contaminated media may be consumed by wildlife. Although terrestrial vertebrates may be exposed to chemicals found in the air via inhalation, this is not considered a significant pathway.

SAP Worksheet No. 11 -- Project Quality Objectives/Systematic Planning Process Statements

(UFP-QAPP Manual Section 2.6.1)

This section describes the development of PQOs using USEPA's seven-step DQO/Systematic Planning Process.

11.1 PROBLEM DEFINITION

Based on site history and the CSM, it is unknown whether site-related contaminants are present in environmental media at SWMU 32 at concentrations that exceed applicable risk-based human health or ecological screening values and IDEM Residential Default Closure Levels (DCLs). Therefore, the site must be investigated to determine whether unacceptable environmental conditions are present and corrective action or additional investigation is necessary. If potentially unacceptable chemical concentrations are detected, initial contaminant delineation data must be collected to aid in planning additional investigations or corrective action.

11.2 IDENTIFY THE INPUTS TO THE DECISION

The following physical and chemical data are needed to attain project objectives:

1. Surface and subsurface soil, sediment, and groundwater chemical data will be collected and analyzed to determine if target analytes are present in site media at concentrations greater than risk-based screening criteria. The list of chemical analytes and Project Screening Levels (PSLs) associated with these analytes for each matrix are presented in Worksheet No. 15. The sampling methods are presented in Worksheet No. 18, and analytical methods are presented in Worksheet No. 19.

2. Subsurface soil screening: Subsurface soil samples will be collected using direct-push technology (DPT). A flame ionization detector (FID) will be used to measure volatile organic compounds (VOCs) and certain semivolatile organic compounds (SVOCs) (including PAH) levels in subsurface soil samples. Analyses will be conducted on the most contaminated subsurface soil interval at each boring location, based on the maximum FID reading. Visual observations will also be used to assist in the identification of subsurface soil with the greatest potential for contamination. The FID will be used in accordance with the manufacturer's guidance.

3. Project Screening Levels: The SWMU 32 Phase I RFI requires chemical data that can be compared to current USEPA and IDEM residential surface and subsurface soil, sediment, and groundwater risk-based screening criteria. A comprehensive listing of the relevant environmental and medium-specific risk-based screening levels for the target analytes are required (specifically, BTEX, naphthalene, and seven Class B2 cPAHs). The risk and regulatory criteria applicable to SWMU 32 include the IDEM RISC Default Closure Tables, Residential and Industrial Closure Levels; USEPA Regions 3, 6 and 9 Residential Regional Screening Levels (R-RSLs) and risk-based migration-to-groundwater Soil Screening Levels (SSLs) for human health risk screening and for use in a Human Health Risk Assessment (HHRA) during a Phase II RFI, if necessary; and appropriate ecological criteria for ecological risk screening. The criterion for each analyte represents the PSL for each environmental matrix listed in Worksheet No. 15. Backup tables for the selection of PSLs are presented in Appendix E.

To conduct comparisons of site data to screening values for surface soil, subsurface soil, sediment, and groundwater and to begin delineation of potential contamination, the selected laboratory(s) should be able to achieve Quantitation Limits (QLs) that are low enough to measure constituent concentrations that are less than the PSLs. In some cases, this may not be achievable for every parameter. The rationale for allowing these deviations is described in the footnotes to Worksheet No. 15. In all cases where the PSL is between the Method Detection Limit (MDL) and QL, the Project Team will accept analytical results that are between the MDL and QL if the results are "J" qualified. J-flagged data will be accepted and used to evaluate achievement of project goals when the PSL is between the QL and MDL, but greater scrutiny will be applied in these cases. Additionally, the inability to quantify select chemicals to PSL levels with confidence will be addressed in the project report. When the PSL is less than the MDL for a particular analyte or analytes, an evaluation of detection limits and the impact on data usability will be discussed in the Phase I RFI Report. Any limitations on the data will be documented at that time and, if significant data gaps remain, additional data will be collected to reduce or eliminate these significant data gaps.

11.3 DEFINE THE STUDY BOUNDARIES

The following items address the horizontal, vertical, and temporal boundaries for the study.

Horizontally, the entire area of SWMU 32 (including the Cell 5 Area, Cell 6 Area, Tanker Unloading Area, and Tanker Fill Station Area) and the Drainage way from the 1987 Release (ditch from the site to Culpepper Branch) will be investigated to determine if chemical concentrations in these areas exceed PSLs. The horizontal boundary of the SWMU 32 area is shown on Figure 10-3 and includes the area enclosed by the chain-link fence and the area of the two tanks east of the fence and the oil/water separator south of the fence. The area enclosed by the fence includes the former location of the six cells and the Tanker Unloading Area and Tanker Fill Station Area to the west and south of the cells. The Drainage way from the 1987 Release includes the open ditch (non-pipe) area south of the site and on both sides of the road. Surface and subsurface soil sample locations will be horizontally aligned.

Vertically, both surface and subsurface soil will be assessed. The interval of interest for surface soil is 0 to 2 feet below ground surface (bgs). Surface soil sample results will be used for direct-contact soil risk screening. Subsurface soil samples will be collected at greater than 2 feet bgs at intervals selected based on field screening with a FID and/or visual observations. Subsurface samples may include fill material but will be focused on the soil just beneath the gravel layer, where gravel is present. The initial interval of interest for subsurface soil is the 1-foot interval between 2 to 10 feet bgs with the maximum FID reading or as selected by the sampler based on visual observations. If there are no elevated FID readings or visual observations that cause a subsurface depth to be selected in a biased manner, then the top 1 foot of soil beneath the gravel layer will be selected or, if no gravel is encountered at a location, the 4 to 5-foot bgs depth will be selected.

At the discretion of the Tetra Tech FOL, if areas of obvious or likely contamination are encountered, additional samples may be collected based on visual observation of staining or discoloration in surface or subsurface soil along the perimeter of the study area boundary. As a result, the study area boundary may be expanded during this investigation.

Sediment throughout the stream bed may potentially be contaminated; however, if sediment is not widely available, depositional areas will be targeted for sampling. Sediment samples will be collected from Culpepper Branch at locations upgradient and downgradient of the location where the Drainage way from the 1987 Release discharges into Culpepper Branch. Upgradient sediment samples will also be collected to represent background or upgradient conditions.

Groundwater generally downgradient of the known release and other operations areas may have been contaminated by releases from the tank farm, including leaks and releases from operations. Upgradient groundwater samples will also be collected to provide a reference population and to help delineate organic contamination. Groundwater will be assessed at the site via temporary wells installed during the initial sampling round. Because there are no known monitoring wells in the vicinity, depth to groundwater is not known, but it is presumed to be less than 20 feet bgs based on the proximity of surface water in Culpepper Branch.

Concentrations of petroleum COC (BTEX, naphthalene, and cPAHs) are anticipated to be relatively unchanged (stable) over the course of time needed to conduct the environmental investigations and into the foreseeable future; therefore, no temporal constraints exist.

SWMU 32 RFI field activities are expected to be performed in early 2010. However, due to the volatility of VOCs (including BTEX) and the length of time since operational activities, surface soil is not expected to contain elevated levels of BTEX compounds.

11.4 DEVELOP THE ANALYTIC APPROACH

The following rules govern data use for determining whether additional investigation is warranted:

- Determine whether chemical concentrations in site media (surface and subsurface soil, sediment, and groundwater) exceed the most conservative (lowest) applicable risk-based human health or ecological screening values (the PSLs).

- If all target analyte concentrations in all site samples are less than the lowest medium-specific PSL then the Project Team, which includes the USEPA RPM, IDEM RPM, Navy RPM, NSA Crane ERSM, and Tetra Tech project members, will recommend No Further Action (NFA) for the site, and the Navy will submit a Closure Report to IDEM.

- For target analytes that are detected in groundwater, if the maximum detected concentration of any analyte exceeds the PSL, then installation of permanent groundwater monitoring wells will be considered by the Project Team to assess and monitor groundwater conditions at the site; otherwise, no additional groundwater samples will be required.

- For each target analyte, if the maximum concentration in any medium exceeds its human health or ecological PSL, then that chemical will be classified as a human health or ecological Contaminant of Potential Concern (COPC) for that medium; otherwise, the chemical will be excluded from further consideration.

The following rules govern data use for contaminant delineation:

- If any concentration of any petroleum COC in the initial round of surface and subsurface soil samples exceed a PSL, then the Tetra Tech PM will determine in concert with the Project Team the degree to which "step-out" samples (vertical or horizontal) are necessary to define the vertical and/or horizontal extent of soil contamination. Factors considered will include the petroleum COC, magnitude and spatial distribution of the exceedance(s), and the overall estimated risk level. Up to one round of four step-out samples (one in each direction) may be collected near each initial sample that exceeds a PSL, in accordance with the IDEM RISC guidance document (IDEM, 2001). A maximum of 24 step-out samples may be included in the Phase I RFI. If more step-out samples are necessary, they will be included in a Phase II RFI.

- The degree to which petroleum COC concentrations exceed the PSLs. The need to collect additional samples will be carefully considered when results, for example, are within 5 percent of screening or background levels. The need to collect additional data will increase with increased number of exceedances and increased contaminant concentrations.

- Considerations of the impact of risk estimations if some contaminant concentrations are not completely delineated.

Decision rules governing data use for site characterization are as follows:

If applicable risk-based human health or ecological screening values are exceeded but risks are not unacceptable, as determined through the human health and ecological risk screening process, the Project Team will meet to discuss a path forward. Such a path could involve one or more of the following:

- Evaluating Industrial or Non-Default Closure (less conservative) criteria as potential options.
- Developing DQOs for further investigation.
- Addressing exceedences as uncertainties in the risk assessment and Corrective Measures Study (CMS).

If any petroleum COC concentration in a sediment sample exceeds a sediment PSL, a co-located surface water sample will be collected from Culpepper Branch, if necessary, during the Phase II RFI.

11.5 SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

The Visual Sample Plan (VSP), Version 5.3.1, software tool was used to determine the number of soil samples to be collected across two decision units at SWMU 32 that represent reasonable risk exposure units. Sample size calculations were determined using naphthalene (PSL of 11 micrograms per kilogram [µg/kg]) as the surrogate for other target analytes. The following key assumptions and performance/acceptance criteria were used to determine the number of soil samples in a decision unit:

- For purposes of statistical analysis, the "null hypothesis" is that the site is "dirty" (i.e., the mean concentration at the site exceeds the action level selected for statistical analysis).

- Sigma - The standard deviation for each decision unit was estimated by dividing the expected range of concentrations by six (USEPA, 2002). Surface and subsurface soil are assumed to be relatively uncontaminated based on the CSM (concentrations ranging from non-detect to 1.5 times the PSL), so the standard deviation for the decision units was estimated as 2.75 µg/kg. Subsurface areas near the 1987 release (Cell 5 Area, Cell 6 Area, Tanker Unloading Area, and Tanker Fill Station Area) are assumed to be slightly more contaminated than other areas, but the standard deviation for this decision unit was also estimated as 2.75 µg/kg.

- Delta - The width of the gray region is the difference between the expected mean concentration and the PSL. The expected mean concentration was set at 80 percent of the PSL, so delta equals 2.2.

- Alpha - Alpha is the tolerance for concluding that the site is "clean" when the site is actually "dirty". If an incorrect decision is to be made, the Project Team prefers to incorrectly take action to remediate a "clean" site, rather than to fail to take action at a "dirty" site. Therefore, the tolerance for concluding that this site is "clean" when the concentration is greater than the PSL was set at 10 percent.

- Beta - The tolerance for concluding that the site is "dirty" when the site is actually "clean" was set at 20 percent also considering the tolerance for incorrectly concluding that the site mean is greater than the PSL when it is actually less than the PSL. This beta value is greater than the alpha value because there is more tolerance for this type of error than for the error of not taking action when a site is "dirty."

- The lower bound of the gray region (LBGR) presented in terms of a percentage of the PSL was set at 80 percent.

The results of the statistical analysis are that a minimum of 21 locations should be sampled from each of the two Decision Units – surface soil and subsurface soil from across the southern portion of the site and surface soil and subsurface soil from across the northern portion of the site. The VSP outputs for the calculations of the sample sizes for these Decision Units are provided in Appendix D. The sampling design presented in Section 11.6 is based on this recommended number of samples to determine the boundaries of contamination and potential remedial areas. All new analytical data collected per the sampling design is expected to meet the QA criteria established in Worksheet Nos. 19 through 37 and the prescribed detection limit requirements for each COC, as identified in Worksheet No. 15.

Because this is a screening investigation based primarily on biased sampling, probability limits for false positive and false negative decision errors were not established for sediment or groundwater samples. Simple comparisons of measured concentrations to PSLs will be used. Sample locations were selected to determine the nature of sediment and groundwater contamination from areas most likely to be contaminated and from presumably uncontaminated areas outside of the impacted areas based on the CSM.

This biased selection of sample locations does not support the use of quantitative statistics to estimate decision performance, as specified in the USEPA QA/G-4, QA/G-5, and QA/G-5S DQO guidance documents (USEPA, 2006a, 2002a, and 2002b, respectively). However, the quantity of samples to be collected in the initial sampling round is sufficient to determine whether unacceptable environmental conditions are present. If all analytical results are less than PSLs, the site will require NFA. The assessment process will involve evaluations of contaminant concentrations and of uncertainty for contaminants that have PSLs less than MDLs to ensure that contaminants are likely to have been detected if present. If all data have been collected as planned and no data points are missing or rejected for quality reasons, the investigation will be considered satisfactory. If any data gaps are identified, including missing or rejected data, the Project Team will assess whether the project objectives have been obtained. This assessment will depend on the number and type of identified data gaps; therefore, a more detailed strategy cannot be presented at this time. All stakeholders, including the IDEM RPM, the Navy RPM and ERSM, and the Tetra Tech PM, will be involved in the final conclusion regarding adequacy of the data.

11.6 DEVELOP THE PLAN FOR OBTAINING DATA

Based on the information presented above, a detailed plan was developed to obtain the necessary data to answer the problem. The sampling design and rationale for all samples that will be collected are provided in Worksheet No. 17.

SAP Worksheet No. 12 -- Measurement Performance Criteria Table – Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPCs)	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Trip Blank	VOCs	One per cooler of VOC samples shipped to laboratory	Accuracy/Bias/ Contamination	No analytes > ½ QL, except common lab contaminants, which must be < QL.	S & A
Field Blank	All analytical groups	One per analysis per laboratory	Accuracy/Bias/ Contamination	No analytes > ½ QL, except common lab contaminants, which must be < QL.	S & A
Equipment Rinsate Blank	All analytical groups	One per 20 field samples per matrix per sampling equipment[1]	Accuracy/Bias/ Contamination	No analytes > ½ QL, except common lab contaminants, which must be < QL.	S & A
Field Duplicate (FD)	All analytical groups	One per 20 field samples per matrix	Precision	Values > 5X QL: Relative Percent Difference (RPD) ≤30%[2] (aqueous)/ ≤50%[3] (solids).	S & A
Matrix Spike (MS)	All analytical groups	One per Sample Delivery Group (SDG) or every 20 samples	Accuracy/Bias	Department of Defense (DoD) Quality Systems Manual (QSM) QC acceptance criteria, at a minimum. Also, within laboratory statistically derived percent recovery (%R) limits.	A
Matrix Spike Duplicate (MSD)	All analytical groups	One per SDG, or every 20 samples	Accuracy/Bias/ Precision	DoD QSM QC acceptance criteria, at a minimum. Also, within statistically derived %R limits; RPD of ≤30%[2] (aqueous)/ ≤50%[3] (solids).	A
Temperature Indicator	All analytical groups	One per cooler	Representativeness	Temperature between 2 and 6 degrees Celsius (4 ± 2 °C).	S

1 – Equipment rinsate blanks will be collected if non-dedicated submersible pumps or other equipment are used.
2 – If duplicate values are < 5x QL for aqueous samples, absolute difference should be < 2x QL.
3 – If duplicate values are < 5x QL for solid samples, absolute difference should be < 4x QL.

SAP Worksheet No. 13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/ collection dates)	How Data Will Be Used	Limitations on Data Use
None	NA	NA	NA	No secondary data will be used.

SAP Worksheet No. 14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

14.1 FIELD INVESTIGATION TASK PLAN

The field tasks are listed below, and short descriptions of these tasks are also provided. All data recording and management procedures are described in Worksheet No. 29.

- Mobilization/Demobilization
- Site-Specific Health and Safety Training
- Utility Clearance
- Monitoring Equipment Calibration
- Surface and Subsurface Soil Sampling
- Sediment Sampling
- Groundwater Well Installation and Development
- Groundwater Sampling
- Investigation-Derived Waste (IDW) Management
- Global Positioning System (GPS) Locating
- Field Decontamination Procedures
- Field Documentation Procedures
- Sample Custody and Shipment Tasks

Mobilization/Demobilization

Mobilization will consist of the delivery of all equipment, materials, and supplies to the site, complete assembly in satisfactory working order of all such equipment at the site, and satisfactory storage at the site of all such materials and supplies. Tetra Tech will coordinate with the Navy to identify appropriate locations for the storage of equipment and supplies. Site-specific health and safety training for all Tetra Tech personnel and subcontractors will be provided as part of the site mobilization.

Demobilization will consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of work.

Site-Specific Health and Safety Training

There are no specialized/non-routine project-specific training requirements or certifications needed by personnel to successfully complete project tasks. All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed the OSHA 40-hour course (and 8-hour refresher, if applicable) in health and safety training. Safety requirements are addressed in greater detail in the site-specific HASP.

Utility Clearance

Prior to commencing any work at NSA Crane, the Comprehensive Work Approval Process (CWAP) will be followed. The CWAP will identify constraints in the work area, such as the locations of eagle's nests, archaeological sites, wetlands, etc., that may affect work at the site and other requirements that must be met prior to commencing work. One week prior to the commencement of any subsurface intrusive activities, the Tetra Tech FOL or designee will contact Indiana Underground Plant Protection Services (IUPPS) to complete a utility clearance ticket for the areas under investigation. Work permits, if required by the facility, will be obtained prior to conducting field activities. The Tetra Tech FOL will be responsible for coordinating these activities.

Monitoring Equipment Calibration

Monitoring equipment calibration procedures are described in Worksheet No. 22.

Sample Collection Tasks

Site-specific Standard Operating Procedures (SOPs) have been developed for field activities at NSA Crane, including sample collection tasks. Sample labeling will be in accordance with SOP-02 (Sample Labeling), and the sample numbering scheme will be in accordance with SOP-03 (Sample Identification and Nomenclature). Methods for recording data will be in accordance with SOP-04 (Sample Custody and Documentation of Field Activities). The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with SOP-05 (Sample Preservation, Packaging, and Shipping). Field SOPs are located in Appendix A.

The sampling and analysis program is outlined in Worksheet No. 18, and the sampling requirements for each type of analysis (i.e., bottleware, preservation, holding time) are listed in Worksheet No. 19. Field and laboratory QC samples will also be collected as outlined in Worksheet No. 20.

Surface and Subsurface Soil Sampling

Surface soil samples and subsurface soil samples are anticipated to be collected using DPT. If unanticipated conditions are encountered, surface soil samples (considered to be from 0 to 2 feet bgs) may be collected with a hand auger by filling the sample jars using either a decontaminated stainless steel trowel or dedicated disposable plastic trowel. Soil samples will be collected in accordance with SOP-07 (Soil Coring and Sampling Using Hand Auger Techniques) located in Appendix A. Subsurface soil samples may be collected using a backhoe or stainless steel hand auger and stainless steel or disposable trowel. The subsurface soil borings will be described by the Site Geologist in accordance with SOP-08 (Soil Sample Logging) and will be screened for evidence of contamination with a FID. Use of the FID will be in accordance with the manufacturer's instructions. Any qualitative visual signs of potential contamination (e.g., soil staining) will be noted on the soil boring log.

VOC samples will be obtained with EnCore™ sampling equipment, preserved and prepared at the laboratory following SW-846 Method 5035, and analyzed following SW-846 Method 8260B. The SVOC samples will be preserved and prepared at the laboratory following SW-846 Method 3541B and analyzed following SW-846 Method 8270C, modified for Selected Ion Monitoring (SIM) for low-level measurements. Field and laboratory QC samples will also be collected.

Sediment Sampling

Sediment sampling procedures discussed in SOP-09 (Sediment Sampling) located in Appendix A will be followed.

Sediment samples for VOC analysis will be obtained with EnCore™ sampling equipment, preserved and prepared at the laboratory following SW-846 Method 5035, and analyzed following SW-846 Method 8260B. SVOC samples will be preserved and prepared at the laboratory following SW-846 Method 3541B and analyzed following SW-846 Method 8270C SIM. The TOC samples will be analyzed by the laboratory following SW-846 Method 9060. Field and laboratory QC samples will also be collected.

Groundwater Temporary Well Installation and Development

The groundwater temporary well (Hydropunch) installation and development procedures to install temporary well points and to collect samples as discussed in SOP-11 (Subsurface Soil and Groundwater Sampling Using Direct-Push Technology), located in Appendix A, will be followed.

Groundwater Sampling

The groundwater sampling procedures discussed in SOP-14 (Measurement of Water Levels), SOP-15 (Low Flow Well Purging and Stabilization), SOP-16 (Monitoring Well Sampling), and SOP-17 (Calibration and Care of Water Quality Meters), located in Appendix A, will be followed.

Groundwater samples for VOC analysis will be preserved and prepared at the laboratory following SW-846 Method 5030 and analyzed following SW-846 Method 8260B. SVOC samples will be preserved and prepared at the laboratory following SW-846 Method 3510C and analyzed following SW-846 Method 8270C SIM. Field and laboratory QC samples will also be collected.

Investigation-Derived Waste Management

It is not anticipated that significant volumes of solid or semi-solid IDW (i.e., soil, sediment, etc.) will be generated during field activities, including installation of temporary groundwater monitoring wells or collection of subsurface samples using DPT or backhoe excavations. Soil will be replaced into the excavation from which it was excavated. If gross contamination is encountered (e.g., any non-soil contaminated material such as free product or soil with FID readings greater than 100 parts per million [ppm]), then excavation will cease. Any grossly contaminated material that is brought to the surface will not be returned to the excavation but will be segregated from other excavated soil and placed on a plastic liner. The grossly contaminated material will be securely staged until arrangements are made for proper off-site disposal. If IDW is generated, the material will be handled in accordance with SOP-10 (Management of Investigation-Derived Waste) located in Appendix A.

Used personal protective equipment (PPE) and other IDW such as DPT plastic sleeves will be bagged and disposed of as regular trash in an appropriate facility waste container.

Global Positioning System Locating

A GPS unit will be used to locate all sampling points in accordance with SOP-01 (Global Positioning System) located in Appendix A. The GPS equipment will be checked on control monuments before and after the day's events each day, and these checks will be documented in the field notebook. To ensure sub-meter accuracy, the GPS SOP requires a minimum of six satellites to capture a position.

Field Decontamination Procedures

Sample containers will be provided certified-clean (I-Chem 300 or equivalent) from each analytical laboratory. Decontamination of sampling equipment will not be necessary for this project if only dedicated and disposable hand trowels will be used. However, if decontamination is necessary, these requirements will apply. Decontamination of reusable sampling equipment (e.g., non-disposable hand trowels, hand augers, DPT or backhoe equipment) will be conducted prior to sampling and between samples at each location. Decontamination of equipment will be conducted according to the sequence established in SOP-06 (Decontamination of Field Sampling Equipment) located in Appendix A.

If a backhoe is used, decontamination of the excavator bucket will be performed over the completed backfilled excavation using a high-pressure spray washer with water supplied by the base. All decontamination water will be allowed to infiltrate to the excavation. In the event that free product is encountered, the excavator bucket wash water will be captured and containerized for sampling and appropriate disposal according to the analysis results.

Field Documentation Procedures

Field documentation will be performed in accordance with SOP-04 located in Appendix A.

A summary of all field activities will be properly recorded in a bound logbook with consecutively number pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use.

At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.
- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.
- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information, including chain-of-custody form numbers, air bill numbers, carriers, times, and dates.
- Descriptions of borehole and monitoring well installation activities and operations.
- Health and safety issues.
- Description of photographs including date, time, photographer, roll and picture number, location, and compass direction of each photograph.

All logbook entries will be written in ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; the person making the correction will initial and date the change.

Sample Custody and Shipment Tasks

Sample custody and shipment tasks are defined in SOP-05 located in Appendix A and are discussed in Worksheet No. 27.

SAP Worksheet No. 15 -- Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: Surface Soil (depth: 0 to 2 feet)
Analytical Group: Select SVOCs – Low-Level PAHs by SIM

Analyte	CAS Number	Project Screening Level (µg/kg)		Project Screening Level References[1]	Project Quantitation Limit Goal (PQLG) (µg/kg)	Empirical	
		HHRA	ERA			QL (µg/kg)	MDL (µg/kg)
Naphthalene	91-20-3	700	29,000	IDEM DCL / Eco SSL	230	10	5
Benzo(a)anthracene	56-55-3	150	1,100	R-RSL / Eco SSL	50	10	5
Chrysene	218-01-9	15,000	1,100	R-RSL / Eco SSL	370	10	5
Benzo(b)fluoranthene	205-99-2	150	1,100	R-RSL / Eco SSL	50	10	5
Benzo(k)fluoranthene	207-08-9	1,500	1,100	R-RSL / Eco SSL	370	10	5
Benzo(a)pyrene	50-32-8	15	1,100	R-RSL / Eco SSL	5.0	5	2.5
Indeno(1,2,3,-cd)pyrene	193-39-5	150	1,100	R-RSL / Eco SSL	50	10	5
Dibenzo(a,h)anthracene	53-70-3	15	1,100	R-RSL / Eco SSL	5.0	5	5

1 Surface soil screening references: R-RSL – USEPA Regions 3, 6 and 9 Regional Screening Levels (RSLs), Direct Contact Residential (2009a); IDEM DCL – IDEM Default Residential Closure Levels (2009); Eco SSL – USEPA's Ecological Soil Screening Levels (2008a). Refer to Appendix E for support documentation.

Matrix: Subsurface Soil (depth: greater than 2 feet)
Analytical Group: Select VOCs (BTEX and MTBE)

Analyte	CAS Number	Project Screening Level (µg/kg)	Project Screening Level References [1]	Project Quantitation Limit Goal (µg/kg)	Empirical	
		HHRA			QL (µg/kg)	MDL (µg/kg)
Benzene	71-43-2	4.6	USEPA SSL	1.5	1.0	0.5
Toluene	108-88-3	12,000	IDEM DCL	4,000	10	5
Ethylbenzene	100-41-4	38	USEPA SSL	12	10	5
Xylenes (total)	1330-20-7	32,000	USEPA SSL	10,000	10	5
MTBE[2]	1634-04-4	54	USEPA SSL	18	10	5

1 Subsurface soil screening references: USEPA SSL – USEPA Regions 3, 6 and 9 Soil Screening Level, Migration to Groundwater, Dilution Attenuation Factor (DAF) = 20 (2009a); IDEM DCL – IDEM Default Residential Closure Levels (2009). Refer to Appendix E for support documentation.
2 MTBE will only be analyzed for the one AST sample.
There is a PSL for human health only (there is no ecological PSL because there is no complete exposure path for ecological receptors).

Matrix: Subsurface Soil (depth: greater than 2 feet)
Analytical Group: Select SVOCs – Low-Level PAHs by SIM

Analyte	CAS Number	Project Screening Level (µg/kg)	Project Screening Level References [1]	Project Quantitation Limit Goal (µg/kg)	Empirical	
		HHRA			QLs (µg/kg)	MDLs (µg/kg)
Naphthalene	91-20-3	11	USEPA SSL	3.6	5	2.5
Benzo(a)anthracene	56-55-3	280	USEPA SSL	93	10	5
Chrysene	218-01-9	25,000	IDEM DCL	8,300	10	5
Benzo(b)fluoranthene	205-99-2	940	USEPA SSL	310	10	5
Benzo(k)fluoranthene	207-08-9	9,200	USEPA SSL	3,000	10	5
Benzo(a)pyrene	50-32-8	92	USEPA SSL	30	5	2.5
Indeno(1,2,3,-cd)pyrene	193-39-5	3,100	IDEM DCL	1,000	10	5
Dibenzo(a,h)anthracene	53-70-3	300	USEPA SSL	100	5	2.5

[1] Subsurface soil screening references: USEPA SSL – USEPA Regions 3, 6 and 9 Soil Screening Level, Migration to Groundwater, DAF = 20 (2009a); IDEM DCL – IDEM Default Residential Closure Levels (2009). Refer to Appendix E for support documentation.
There is a PSL for human health only (there is no ecological PSL because there is no complete exposure path for ecological receptors).

Matrix: Sediment (depth: 0 to 6 inches)
Analytical Group: Select VOCs (BTEX)

Analyte	CAS Number	Project Screening Level (µg/kg)		Project Screening Level References [1]	Project Quantitation Limit Goal (µg/kg)	Empirical	
		HHRA	ERA			QLs (µg/kg)	MDLs (µg/kg)
Benzene	71-43-2	34	142	IDEM DCL / R5 ESL	11	10	5
Toluene	108-88-3	12,000	1,220	IDEM DCL / R5 ESL	400	10	5
Ethylbenzene	100-41-4	5,700	175	R-RSL / R5 ESL	58	10	5
Xylenes (total)	1330-20-7	60,000	433	R-RSL / R5 ESL	140	10	5

[1] Sediment screening references: R-RSL – USEPA Regions 3, 6 and 9 RSL, Direct Contact Residential (2009a); IDEM DCL – IDEM Default Residential Closure Levels (2009); R5 ESL – USEPA Region 5 Ecological Screening Level (2005). Refer to Appendix E for support documentation.

Matrix: Sediment (depth: 0 to 6 inches)
Analytical Group: Select SVOCs – Low-Level PAHs by SIM

Analyte	CAS Number	Project Screening Level (µg/kg)		Project Screening Level References [1]	Project Quantitation Limit Goal (µg/kg)	Empirical	
		HHRA	ERA			QLs (µg/kg)	MDLs (µg/kg)
Naphthalene	91-20-3	700	29,000	IDEM DCL / Eco SSL	230	10	5
Benzo(a)anthracene	56-55-3	150	1,100	R-RSL / Eco SSL	50	10	5
Chrysene	218-01-9	15,000	1,100	R-RSL / Eco SSL	360	10	5
Benzo(b)fluoranthene	205-99-2	150	1,100	R-RSL / Eco SSL	50	10	5
Benzo(k)fluoranthene	207-08-9	1,500	1,100	R-RSL / Eco SSL	360	10	5
Benzo(a)pyrene	50-32-8	15	1,100	R-RSL / Eco SSL	5.0	5	2.5
Indeno(1,2,3,-cd)pyrene	193-39-5	150	1,100	R-RSL / Eco SSL	50	10	5
Dibenzo(a,h)anthracene	53-70-3	15	1,100	R-RSL / Eco SSL	5.0	5	2.5

[1] Sediment screening references: R-RSL – USEPA Regions 3, 6 and 9 RSL, Direct Contact Residential (2009a); IDEM DCL – IDEM Default Residential Closure Levels (2009); Eco SSL – USEPA's Ecological Soil Screening Levels (2005). Refer to Appendix E for support documentation.

Matrix: Groundwater
Analytical Group: Select VOCs (BTEX)

Analyte	CAS Number	Project Screening Level (µg/L)	Project Screening Level References [1]	Project Quantitation Limit Goal (µg/L)	Empirical	
		HHRA			QLs (µg/L)	MDLs (µg/L)
Benzene	71-43-2	5	USEPA MCL, IDEM DCL	1.6	1.0	0.5
Toluene	108-88-3	1,000	USEPA MCL, IDEM DCL	330	1.0	0.5
Ethylbenzene	100-41-4	700	USEPA MCL, IDEM DCL	230	1.0	0.5
Xylenes (total)	1330-20-7	10,000	USEPA MCL, IDEM DCL	3,300	1.0	0.5

[1] Groundwater screening references: USEPA MCL – National Primary Drinking Water Regulations, Maximum Contaminant Level (MCL) (2009b); IDEM DCL – IDEM Groundwater Default Closure Level (2009). Refer to Appendix E for support documentation.
There is a PSL for human health only (there is no ecological PSL because there is no complete exposure path for ecological receptors).

Matrix: Groundwater
Analytical Group: Select SVOCs - Low Level PAHs by SIM

Analyte	CAS Number	Project Screening Level (µg/L)	Project Screening Level References [1]	Project Quantitation Limit Goal (µg/L)	Empirical	
		HHRA			QLs (µg/L)	MDLs (µg/L)
Naphthalene	91-20-3	8.3	IDEM DCL	2.7	0.10	0.05
Benzo(a)anthracene	56-55-3	1.2	IDEM DCL	0.40	0.05	0.02
Chrysene	218-01-9	120	IDEM DCL	40	0.10	0.05
Benzo(b)fluoranthene	205-99-2	1.2	IDEM DCL	0.40	0.05	0.02
Benzo(k)fluoranthene	207-08-9	12	IDEM DCL	4.0	0.10	0.05
Benzo(a)pyrene	50-32-8	0.2	IDEM DCL	0.066	0.05	0.02
Indeno(1,2,3,-cd)pyrene	193-39-5	1.2	IDEM DCL	0.40	0.10	0.05
Dibenzo(a,h)anthracene	53-70-3	0.12	IDEM DCL	0.040	0.05	0.02

[1] Groundwater screening references: IDEM DCL – IDEM Groundwater Default Closure Level (2009). Refer to Appendix E for support documentation.
There is a PSL for human health only (there is no ecological PSL because there is no complete exposure path for ecological receptors).

SAP Worksheet No. 16 -- Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Soil Sampling, Sediment Sampling, and Groundwater Sampling	Tetra Tech	3/1/2010	3/15/2010	Phase I RFI Report, SWMU 32	9/10/2010 (draft) 3/9/2011 (final)

SAP Worksheet No. 17 -- Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

Samples will be collected at SWMU 32 to determine whether chemical concentrations in site media (surface and subsurface soil, sediment, and groundwater) exceed the most conservative (lowest) applicable risk-based human health or ecological screening values. If these screening values are exceeded, the Project Team will evaluate human health and ecological risks and delineate the nature and extent of contamination at the site. Data from this sampling event will be used to determine whether unacceptable residual petroleum contamination exists in surface or subsurface soil within the footprint of the former tank farm area, in surface soil along the corridor where fuel oil spilled to nearby surface water, in nearby sediment beneath the surface water of Culpepper Branch, or in groundwater below the site.

The Phase I RFI field data collection program will be within the boundaries of SWMU 32, the Drainage way from the 1987 Release, and Culpepper Branch, as shown on Figure 10-2. Initial sampling will be performed to determine if there are fuel oil petroleum COCs (the target analytes) in environmental media as a result of former site operations. If the maximum concentration of any petroleum COC exceeds an applicable human health PSL or ecological PSL, additional sampling may be required to define the nature and extent of contamination and to support human health and ecological risk assessments.

Soil

The initial soil sampling program consists of collecting surface soil and subsurface soil from across the site. Surface and subsurface soil samples will be vertically aligned. The horizontal locations of these samples will be randomly selected on a statistical basis that will support a subsequent risk assessment and/or RCRA closure recommendation, as appropriate. Surface soil samples will be collected from 0 to 2 feet bgs and will be analyzed for petroleum COCs except BTEX. If any release of these VOCs occurred during site operations, they would likely not still be present at the surface due to the volatile nature of these compounds. Subsurface soil samples will be collected from the sampling interval with the greatest potential for contamination based on field screening techniques and will be analyzed for all petroleum COCs. This approach, coupled with the ability to make field decisions to delineate the extent of contamination as described below, supports both the delineation of contamination and the calculation of risk estimates.

The number of soil samples to be collected for each decision unit were calculated as described in Section 11.5. Surface and subsurface soil samples will be collected from within the following two Decision Units at the site:

- Across the southern portion of the site (Decision Unit #1).
- Across the northern portion of the site (Decision Unit #2).

The proposed Phase I soil sampling locations in Decision Units #1 and #2 are shown on Figure 17-1. The planned sample location coordinates were determined using VSP Version 5.3.1 software, and a table identifying these coordinates is provided in Appendix D. If site conditions require a location to be moved (i.e., boulder, tree, etc.), the field sampler will move 5 feet north of the planned location to collect the necessary sample. If this occurs, the field sampler will document the reason in the field logbook. The following initial Phase I soil sampling will be performed:

- **Southern Surface Soil (Decision Unit #1).** Twenty-one surface soil samples will be collected from across the southern portion of the site, encompassing the areas within the 1987 release area, based on statistically generated random locations across the decision unit Decision Unit #1 includes Cell Area 5, Cell Area 6, Tanker Unloading Area, and Tanker Fill Area, as indicated on Figure 11-1. Surface soil samples will be collected at depths of 0 to 2 feet bgs and analyzed for petroleum COCs except BTEX.

- **Southern Subsurface Soil (Decision Unit #1).** Twenty-one subsurface soil samples will be collected from across the southern portion of the site at Decision Unit #1 surface soil sample locations. Sample depth at each location will be selected in the field based on the results of screening techniques to identify the sampling interval with the greatest potential for contamination as described in Worksheet No. 11, Sections 11.2 and 11.3. Subsurface soil samples will be collected at a minimum depth of 2 feet bgs using DPT equipment, if possible, and analyzed for petroleum COCs. If the presence of a gravel layer located beneath Cell Area 6 or other subsurface conditions prevent the use of DPT to collect subsurface soil samples, other equipment including but not limited to a backhoe or Geoprobe with auger capability, may be employed to collect these samples.

- **Northern Surface Soil (Decision Unit #2).** Twenty-one surface soil samples will be collected from across the northern portion of the site, encompassing the areas outside of the 1987 release area, based on statistically generated random locations across the Decision Unit. This Decision Unit includes Cells 1 through 4 and areas outside the cells, as indicated on Figure 11-1. Surface soil samples will be collected at depths of 0 to 2 feet bgs and analyzed for petroleum COCs except BTEX.

- **Northern Subsurface Soil (Decision Unit #2).** Twenty-one subsurface soil samples will be collected from across the northern portion of the site at Decision Unit #2 surface soil sample locations. Sample depths will be selected in the field based on the results screening techniques to identify the sampling interval with the greatest potential for contamination as discussed in Worksheet No. 11, Sections 11.2 and 11.3. Subsurface soil samples will be collected at a minimum depth of 2 feet bgs using DPT equipment and analyzed for petroleum COCs. If subsurface conditions prevent the use of DPT to collect subsurface soil samples, other equipment including but not limited to a backhoe or Geoprobe with auger capability, may be employed to collect these samples.

The forty-two surface soil samples (plus three duplicate samples for QC purposes) and 42 subsurface soil samples (plus three duplicate samples for QC purposes) will be collected and analyzed for certain petroleum COCs as identified in the IDEM RISC guidance document, which include BTEX, naphthalene and seven cPAHs, which require analysis to low levels to support future risk assessments, if necessary. Due to the volatile nature of BTEX compounds, surface soil samples will not be analyzed for BTEX. The planned soil sample locations are presented on Figure 17-1.

Phase I soil samples will also be collected from the following areas:

- **Drainage way from 1987 Release.** Three surface and three subsurface soil samples (plus one duplicate sample for QC purposes) will be collected from the drainage ditch from Cell 6 to Culpepper Branch to assess the potential residual impact of the 1987 spill between the site and Culpepper Branch. One sample will be collected near Cell 6, one sample will be collected from the ditch just before it enters the pipe and flows under Highway H-5, and one sample will be collected from of the ditch approximately half-way between Highway H-5 and Culpepper Branch (as indicated on Figure 17-2). Surface soil samples will be collected at depths of 0 to 2 feet bgs and analyzed for petroleum COCs except BTEX. Subsurface soil samples will be collected at a minimum depth of 2 feet bgs using DPT equipment and analyzed for petroleum COCs.

- **Former Gasoline AST.** One subsurface soil sample near the former location of the 2,000-gallon horizontal AST in the southwestern portion of the site (as indicated on Figure 17-2) will be analyzed for petroleum COCs, including the Select VOCs of BTEX and MTBE, and the Select SVOCs of naphthalene and seven cPAHs. MTBE is a component of reformulated gasoline and typically associated with soil impacted by gasoline spills. The sample depth will be selected in the field based on the results of screening techniques to identify the sampling interval with the greatest potential for contamination. The subsurface soil sample will be collected at a minimum depth of 2 feet bgs using DPT equipment.

Sediment

Proposed Phase I sediment sample locations are shown on Figure 17-2. Three sediment samples (plus one duplicate sample for QC purposes) will be collected from Culpepper Branch to assess potential migration of petroleum COCs into Culpepper Branch via direct surficial runoff or by groundwater infiltration. One sediment sample will be collected upgradient of the point where the 1987 release entered Culpepper Branch, and two sediment samples will be collected downgradient of that point at 100-foot intervals. Sediment samples will be collected from 0 to 6 inches bgs and analyzed for petroleum COCs. Sediment samples will be analyzed for petroleum COCs, which include Select VOCs (BTEX) and Select

SVOCs (naphthalene and seven cPAHs). Sediment samples will also be analyzed for total organic carbon (TOC) to support site-specific risk calculations. Sediment samples will be collected by filling sample jars using either a decontaminated stainless steel trowel or dedicated disposable plastic trowel.

Surface water samples will not be collected in Phase I because it is highly unlikely based on the length of time since the 1987 spill that residual petroleum COCs could be impacting surface water.

<u>Groundwater</u>

Proposed Phase I groundwater sample locations are shown on Figure 17-3. Three groundwater samples (plus one duplicate sample for QC purposes) will be collected from temporary wells (Hydropunch) installed at the site and analyzed for petroleum COCs. One groundwater sample will be collected from a temporary well upgradient of the site, and two groundwater samples will be collected from temporary wells located downgradient of areas of the site with the greatest potential for contamination based on historical data and field screening observations. Groundwater samples will be analyzed for Select VOCs (BTEX) and Select SVOCs (naphthalene and seven cPAHs). Groundwater samples will also be analyzed for water quality parameters including pH, specific conductivity, turbidity, temperature, and DO to support field sampling decisions and site-specific risk calculations. The need for installation of permanent monitoring wells will be determined based on analytical results from these temporary monitoring wells.

<u>Additional Sampling</u>

Additional sampling will be performed in a Phase II RFI if initial sampling (described above) results indicate that current levels of petroleum COCs are greater than PSLs. Additional samples may include surface soil, subsurface soil, co-located surface water and sediment in Culpepper Branch, and groundwater from new permanent monitoring wells.

Surface water samples will only be collected if a sediment sample result exceeds a PSL, as a future Phase II RFI activity under a separate SAP. Water quality parameters (pH, specific conductivity, turbidity, temperature, and dissolved oxygen [DO]) will be recorded at each surface water sampling location.

<u>Field Quality Control Samples</u>

Field QC samples to collected as part of the Phase I RFI include field duplicates, trip blanks, equipment rinsate blanks, and field blanks. Worksheet No. 20 presents the field QC sample summary. Also, additional sample volume will be collected as necessary for laboratory QC analysis of MS/MSD samples for VOCs and SVOCs.

SAP Worksheet No. 18 -- Sampling Locations and Methods/SOP Requirements Table
(UFP-QAPP Manual Section 3.1.1)

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
SWMU 32 Decision Unit 1-01	32SS-01-0002 and 32SS-FDXXXXXX-01[2]	Soil	0 - 2	Select SVOCs	1 + 1 FD	SOP-07, SOP-08
	32SB-01-XXXX[3] and 32SB-FDXXXXXX-01[2]	Soil	>2[4]	VOCs (BTEX)	1 + 1 FD	
				Select SVOCs	1 + 1 FD	
SWMU 32 Decision Unit 1-02	32SS-02-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-02-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-03	32SS-03-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-03-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-04	32SS-04-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-04-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-05	32SS-05-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-05-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-06	32SS-06-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-06-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-07	32SS-07-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-07-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-08	32SS-08-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-08-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-09	32SS-09-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-09-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-10	32SS-10-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-10-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
SWMU 32 Decision Unit 1-11	32SS-11-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-11-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-12	32SS-12-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-12-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-13	32SS-13-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-13-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-14	32SS-14-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-14-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-15	32SS-15-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-15-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-16	32SS-16-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-16-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-17	32SS-17-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-17-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-18	32SS-18-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-18-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-19	32SS-19-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-19-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-20	32SS-20-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-20-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 1-21	32SS-21-0002 and 32SS-FDXXXXXX-02[2]	Soil	0 - 2	Select SVOCs	1 + 1 FD	SOP-07, SOP-08
	32SB-21-XXXX[3] and 32SB-FDXXXXXX-02[2]	Soil	>2 [4]	VOCs (BTEX)	1 + 1 FD	
				Select SVOCs	1 + 1 FD	

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[(1)]
SWMU 32 Decision Unit 2-22	32SS-22-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-22-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-23	32SS-23-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-23-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-24	32SS-24-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-24-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-25	32SS-25-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-25-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-26	32SS-26-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-26-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-27	32SS-27-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-27-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-28	32SS-28-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-28-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-29	32SS-29-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-29-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-30	32SS-30-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-30-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-31	32SS-31-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-31-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-32	32SS-32-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-32-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-33	32SS-33-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-33-XXXX[(3)]	Soil	>2 [(4)]	VOCs (BTEX)	1	
				Select SVOCs	1	

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference(1)
SWMU 32 Decision Unit 2-34	32SS-34-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-34-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-35	32SS-35-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-35-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-36	32SS-36-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-36-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-37	32SS-37-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-37-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-38	32SS-38-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-38-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-39	32SS-39-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-39-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-40	32SS-40-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-40-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Decision Unit 2-41	32SS-41-0002 and 32SS-FDXXXXXX-03(2)	Soil	0 - 2	Select SVOCs	1+ 1 FD	SOP-07, SOP-08
	32SB-41-XXXX(3) and 32SB-FDXXXXXX-03(2)	Soil	>2 (4)	VOCs (BTEX)	1+ 1 FD	
				Select SVOCs	1+ 1 FD	
SWMU 32 Decision Unit 2-42	32SS-42-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-42-XXXX(3)	Soil	>2 (4)	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Drainage Way 01	32SS-DW01-0002 and 32SS-FDXXXXXX-01(2)	Soil	0 - 2	Select SVOCs	1 + 1 FD	SOP-07, SOP-08
	32SB-DW01-XXXX(3) And 32SB-FDXXXXXX-01(2)	Soil	>2 (4)	VOCs (BTEX)	1 + 1 FD	
				Select SVOCs	1 + 1 FD	

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
SWMU 32 Drainage Way 02	32SS-DW02-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-DW02-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Drainage Way 03	32SS-DW03-0002	Soil	0 - 2	Select SVOCs	1	SOP-07, SOP-08
	32SB-DW03-XXXX[3]	Soil	>2 [4]	VOCs (BTEX)	1	
				Select SVOCs	1	
SWMU 32 Former Gasoline AST	32SB-ST01-XXXX[3]	Soil	>2 [4]	VOCs (BTEX + MTBE)	1	SOP-07, SOP-08
				Select SVOCs	1	
SWMU 32 Sediment 01	32SD-01-0006 and 32SD-FDXXXXXX-01[2]	Sediment	0 – 0.5	VOCs (BTEX)	1 + 1 FD	SOP-09
				Select SVOCs	1 + 1 FD	
SWMU 32 Sediment 02	32SD-02-0006	Sediment	0 – 0.5	VOCs (BTEX)	1	SOP-09
				Select SVOCs	1	
SWMU 32 Sediment 03	32SD-03-0006	Sediment	0 – 0.5	VOCs (BTEX)	1	SOP-09
				Select SVOCs	1	
				Select SVOCs	1	
SWMU 32 Groundwater 01	32GW-01 and 32GW-FDXXXXXX-01[2]	Groundwater	Shallow	VOCs (BTEX)	1 + 1 FD	SOP-11, SOP-14, SOP-15, SOP-16, SOP-17
				Select SVOCs	1 + 1 FD	
SWMU 32 Groundwater 02	32GW-02	Groundwater	Shallow	VOCs (BTEX)	1	SOP-11, SOP-14, SOP-15, SOP-16, SOP-17
				Select SVOCs	1	
SWMU 32 Groundwater 03	32GW-03	Groundwater	Shallow	VOCs (BTEX)	1	SOP-11, SOP-14, SOP-15, SOP-16, SOP-17
				Select SVOCs	1	

1 SOP or worksheet that describes the sample collection procedures (Worksheet No. 21).
2 Field duplicate locations may change in the field based on visual and olfactory observations and FID readings, and "XXXXXX" represents date collected.
3 "XXXX" represents depth of the sample, which will be determined in the field. For example, if sample is collected from 4 to 5 feet, the depth will be recorded as 0405.
4 If there are no elevated FID readings or visual observations that cause a subsurface depth to be selected in a biased manner, the top 1 foot of soil beneath the gravel layer will be selected, or the 4-5 feet bgs depth will be selected if there is no gravel at a particular soil sample location.

SAP Worksheet No. 19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference[1]	Containers (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Surface Soil, Subsurface Soil, and Sediment	Select VOCs	SW-846 5035/8260B Empirical SOP-202	3 – 5-gram (g) EnCores™	5 g	Cool to (4 ± 2) °C; no headspace	48 hours for preparation; 14 days to analysis
	Select SVOCs	SW-846 3541B/8270C Modified for SIM Empirical SOP-329/231	1 – 4-ounce (oz) wide-mouth glass jar	15 g	Cool to (4 ± 2) °C	14 days to extraction; 40 days analysis
Groundwater and Aqueous Field QC Blanks	Select VOCs	SW-846 5030/8260B Empirical SOP-202	3 – 40-milliliter (mL) clear glass vials	40 mL	Cool to (4 ± 2) °C Hydrochloric acid (HCl) to pH < 2	14 days to analysis
	Select SVOCs	SW-846 3510C/8270C Modified for SIM Empirical SOP-300/231	2 – 1-liter (L) amber glass bottles	1 L	Cool to (4 ± 2) °C	7 days for preparation; 40 days to analysis

1 SOP or worksheet that describes the sample collection procedures (Worksheet No. 21).

SAP Worksheet No. 20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs (1)	No. of Field Blanks	No. of Equip. Blanks	No. of VOA Trip Blanks	No. of PT(2) Samples	Total No. of Samples to Lab
Surface Soil	Select SVOCs	45	4	4	1	4	NA	0	54
Subsurface Soil	Select VOCs (BTEX)	45	4	4	1	4	15	0	69
Subsurface Soil	Select VOCs (BTEX plus MTBE)	1	0	0	0	0	0	0	1
Subsurface Soil	Select SVOCs	46	4	4	0	4	NA	0	54
Sediment	Select VOCs (BTEX)	3	1	1	0	1	0	0	5
Sediment	Select SVOCs	3	1	1	0	1	NA	0	5
Sediment	TOC	3	1	1	0	1	NA	0	5
Groundwater	Select VOCs (BTEX)	3	1	1	0	1	1	0	6
Groundwater	Select SVOCs	3	1	1	0	1	NA	0	5

1 Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field. MS/MSDs are not included in the total number of samples sent to the laboratory.

2 PT – Proficiency Test samples.

SAP Worksheet No. 21 -- Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-01	Global Positioning System, 09/09, Rev. 0	Tetra Tech	GPS unit	Y (project-specific)	Contained in Appendix A
SOP-02	Sample Labeling, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-03	Sample Identification Nomenclature, 11/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-04	Sample Custody and Documentation of Field Activities, 09/09, Rev. 0	Tetra Tech	Field logbook, sample log sheets, boring logs	Y (project-specific)	Contained in Appendix A
SOP-05	Sample Preservation, Packaging, and Shipping, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-06	Decontamination of Field Sampling Equipment, 09/09, Rev. 0	Tetra Tech	Decontamination equipment, scrub brushes, 5-gallon buckets, spray bottles, phosphate free detergent, deionized water	Y (project-specific)	Contained in Appendix A
SOP-07	Soil Coring and Sampling Using Hand Auger Techniques, 09/09, Rev. 0	Tetra Tech	Stainless steel auger bucket, extension rods, and T-handle	Y (project-specific)	Contained in Appendix A
SOP-08	Soil Sample Logging, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-09	Sediment Sampling, 09/09, Rev. 0	Tetra Tech	Stainless steel or disposable trowels	Y (project-specific)	Contained in Appendix A
SOP-10	Management of Investigation-Derived Waste, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-11	Subsurface Soil and Groundwater Sampling Using Direct-Push Technology, 11/09, Rev. 0	Tetra Tech	DPT Rig	Y (project-specific)	Contained in Appendix A
SOP-12	Monitoring Well Installation, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	
SOP-13	Monitoring Well Development, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-14	Measurement of Water Levels, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-15	Low-Flow Well Purging and Stabilization, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-16	Monitoring Well Sampling, 09/09, Rev. 0	Tetra Tech	NA	Y (project-specific)	Contained in Appendix A
SOP-17	Calibration and Care of Water Quality Meters, 09/09, Rev. 0	Tetra Tech	Multi-parameter water quality meter, such as a Horiba U-22	Y (project-specific)	Contained in Appendix A

SAP Worksheet No. 22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]	Comments
FID	Calibration and Visual Inspection	Daily	Manufacturer's guidance.	Replace	Tetra Tech FOL or designee	Manufacturer's guidance	To be used to determine the subsurface soil depth that is most impacted for biased sample collection.
GPS	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision (HDOP) <3, number of satellites at least six.	Wait for better signal, replace unit, or choose alternate location technique	Tetra Tech FOL or designee	SOP-01	SOP located in Appendix A.
DPT Rig/ Backhoe / Excavating Machinery	Inspection	Daily	Equipment inspection sheet criteria.	Replace	Tetra Tech FOL or designee	SOP-08	SOP located in Appendix A.
Disposable Hand Trowel	Inspection	Per use	NA.	Replace	Tetra Tech FOL or designee	SOP-08	SOP located in Appendix A.
Multi-Parameter Water Quality Meter	Visual Inspection, Calibration	Daily	Manufacturer's guidance.	Replace	Tetra Tech FOL or designee	SOP-17	SOP located in Appendix A.
Turbidity Meter	Visual Inspection, Calibration	Daily	Manufacturer's guidance; Calibrations must bracket expected values. Initial Calibration Verification (ICV) must be <10 Nephelometric Turbidity Units (NTUs).	Replace	Tetra Tech FOL or designee	SOP-17	SOP located in Appendix A.

1 Specify the appropriate reference letter or number from the Project Sampling SOP References Table (Worksheet No. 21).

SAP Worksheet No. 23 -- Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SOP-202	GC/MS Volatiles by EPA Method 624 and SW-846 Method 8260B Including Appendix IX Compounds (Revision 21, 09/11/08)	Definitive	Soil, sediment, groundwater and aqueous field QC samples – VOCs	Gas Chromatograph/ Mass Spectrometer (GC/MS)	Empirical	N
SOP-221	Total Organic Carbon (TOC), SM5310C, SW846 Method 9060, and Lloyd Kahn Method (Revision 7, 10/27/08)	Definitive	Sediment - TOC	Non-Dispersive Infrared (NDIR)	Empirical	N
SOP-231	GC/MS Low Level PAHs by SW-846 Method 8270C SIM (Revision 3, 1/16/09)	Definitive	Soil, sediment, groundwater and aqueous field QC samples – Low-Level SVOCs	GC/MS	Empirical	N
SOP-300	GC/MS-Semi-Volatile BNA-Aqueous Matrix Extraction Using SW-846 Method 3510C for 8270C/625 Analysis (Revision 17, 9/23/28)	Definitive	Groundwater and aqueous field QC samples – Low-Level SVOCs	None	Empirical	N
SOP-329	Soxhlet Extraction – BNA and Pest/PCB Using SW846 Method 3541 (Revision 16, 9/24/08)	Definitive	Soil, and sediment, – Low-Level SVOCs	None	Empirical	N
SOP-404	Laboratory Sample Receiving, Log In and Storage Standard Operating Procedures (Revision 12, 01/05/09)	Definitive	Various	None	Empirical	N
SOP-405	Analytical Laboratory Waste Disposal (Revision 4, 09/26/03)	Definitive	Various	None	Empirical	N
SOP-410	Standard Operating Procedure (SOP) for Laboratory Sample Storage, Secure Areas and Sample Custody (Revision 6, 09/08/08)	Definitive	Various	None	Empirical	N

SAP Worksheet No. 24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference(1)
GC/MS VOCs	Tuning	Prior to initial Calibration (ICAL) and at the beginning of each 12-hour analytical sequence.	Must meet the ion abundance criteria required by the method. No samples may be accepted without a valid tune.	Manual tuning; replacement of the ion source or filament.	Laboratory Manager	SOP-202
	ICAL – A minimum of a 5-point calibration curve is analyzed	After major maintenance; upon second consecutive failure of Continuing Calibration Verification (CCV) standard.	System Performance Check Compounds (SPCCs) average Response Factors (RFs) 1,1,2,2-tetrachloroethane and chlorobenzene ≥0.30; chloromethane, 1,1-dichloroethane and bromoform ≥0.10; Percent Relative Standard Deviation (%RSD) for RFs ≤30% for Calibration Check Compounds (CCCs); and: (Option 1): %RSD ≤15% for all other compounds. If not met (Option 2): Linear least squares regression: Linear Regression Correlation Coefficient (r) ≥0.995.	Repeat calibration, if criterion is not met.	Laboratory Manager	
	ICV - Second source	Once after each ICAL, prior to beginning a sample run.	All analytes ≤20 Percent Difference or Percent Drift (≤20%D) from the true value.	Investigate problem and verify second source standard. Reanalyze ICAL.	Laboratory Manager	
	CCV	Daily before analysis and every 12 hours after the analysis of the tuning standard.	CCCs ≤20%D; SPCC RFs ≥ 0.10 & 0.30 (compounds as listed above in ICAL block).	Investigate cause and repeat injection. Repeat initial calibration and reanalyze all samples analyzed since the last successful CCV.	Laboratory Area Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference(1)
GC/MS SVOCs by SIM (Low- Level PAHs)	Tuning	Prior to ICAL and at the beginning of each 12-hour analytical sequence.	Must meet the ion abundance criteria required by the method. No samples may be accepted without a valid tune.	Manual tuning; replacement of the ion source or filament.	Laboratory Manager	SOP-231
	ICAL – A minimum of a 5-point calibration curve is analyzed	After major maintenance; upon second consecutive failure of CCV standard.	SPCC RFs ≥0.050 (≥0.010 for SIM); %RSD ≤30% for the CCCs; and (Option 1): %RSD ≤15% for all other compounds. If not met (Option 2): Linear least squares regression: r ≥ 0.995.	Repeat calibration, if criterion is not met.	Laboratory Manager	
	ICV - Second source	Once after each ICAL, prior to beginning a sample run.	SPCC RFs ≥0.050 (≥0.010 for SIM); CCCs ≤20%D (≤30%D for SIM).	Investigate problem and verify second source standard. Reanalyze ICAL.	Laboratory Manager	
	CCV	Daily before analysis and every 12 hours after the analysis of the tuning standard.	SPCC RFs ≥0.050 (≥0.010 for SIM); CCCs ≤20%D (≤30%D for SIM).	Investigate cause and repeat injection. Repeat ICAL and reanalyze all samples analyzed since last successful CCV.	Laboratory Area Supervisor	
TOC Analyzer	ICAL	Daily prior to sample analysis.	Linear Regression Correlation Coefficient ≥0.9950.	Recalibrate.	Laboratory Manager	SOP-221
	ICV - Second source	Once after each ICAL, prior to beginning a sample run.	90-110 %R of the true value.	Recalibrate.	Laboratory Manager	
	CCV	After each 10 field samples and at the end of the analytical sequence.	90-110 %R of the true value.	Recalibrate.	Laboratory Area Supervisor	

1 Specify the appropriate reference letter or number from the Analytical SOP References Table (Worksheet No. 23).

SAP Worksheet No. 25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference(1)
GC/MS	Replace/clean ion source; clean injector; replace liner; replace/clip capillary column. Flush/replace tubing on purge and trap devise; replace trap.	Select VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria.	Repeat maintenance activity or remove from service.	Laboratory Manager	SOP-202
GC/MS	Replace/clean ion source; clean injector; replace liner; replace/clip capillary column. Flush/replace tubing on purge and trap devise; replace trap.	Select SVOCs – Low-Level PAHs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria.	Repeat maintenance activity or remove from service.	Laboratory Manager	SOP-231
TOC Analyzer	Replace sample tubing, clean sample boat, replace syringe.	TOC	Tubing, sample boat, syringe	As needed	Must meet initial and/or continuing calibration criteria.	Repeat maintenance activity or remove from service.	Laboratory Manager	SOP-221

1 Specify the appropriate reference letter or number from the Analytical SOP References Table (Worksheet No. 23).

SAP Worksheet No. 26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): George Ten Eyck / Tetra Tech
Sample Packaging (Personnel/Organization): George Ten Eyck / Tetra Tech
Coordination of Shipment (Personnel/Organization): George Ten Eyck / Tetra Tech
Type of Shipment/Carrier: Overnight courier service (Federal Express)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodians / Empirical
Sample Custody and Storage (Personnel/Organization): Sample Custodians / Empirical
Sample Preparation (Personnel/Organization): Preparation laboratory staff / Empirical
Sample Determinative Analysis (Personnel/Organization): GC/MS / Empirical
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 days from sample receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days from submittal of final report
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodians / Empirical

SAP Worksheet No. 27 – Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

Field Sample Custody Procedures

Following sample collection into the appropriate bottleware, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble wrap to protect the bottleware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The selected laboratory will provide pre-preserved sample containers for sample collection. Samples will be maintained at 4 ± 2 °C until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for off-site laboratory analysis will be preserved, packaged, and shipped in accordance with SOP-05 (Appendix A).

Chain-of-Custody Procedures

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., Federal Express). For all samples collected, chain-of-custody forms will document the date and time of sample collection, sampler's name, and names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. SOP-04 (Appendix A) provides further details on the chain-of-custody procedure.

Laboratory Sample Custody Procedures

Chain-of-custody requirements are also documented with instructions contained in each shipment from the laboratory. Laboratory SOPs are provided in Appendix B.

Sample Designation System

Each sample collected for analysis will be assigned a unique sample tracking number that will consist of a multi-segment alphanumeric code that identifies the site, sample type (sample medium or QC sample designation), sample location, and sample depth. SOP-03 addresses sample identification nomenclature (Appendix A). The alphanumeric coding system to be used is as follows:

NN	AA	AANN or NN	NNNN (Soil and sediment only)
SWMU Number	Sample Matrix Code	Sample Location and Number, or QC Sample Designation	Sample Depth

Character Type:

A = Alpha
N = Numeric

SWMU Number (NN):

32 = SWMU 32

Sample Matrix Code (AA):

SS = Surface Soil Sample
SB = Subsurface Soil Sample

SD = Sediment Sample
GW =Groundwater Sample

Sample Location (AA – if appropriate) and Sample Number (NN)

DW = Drainage Way
ST = Storage Tank

Note: Sample Location label (AA) will be used for non-Decision Unit surface soil and subsurface soil samples from Drainage Way-DW and Gasoline AST –ST. DW and ST samples will also include a Sample Number-NN. Surface soil, subsurface soil, sediment, and groundwater samples will only have a Sample Number- NN.

QC Sample Designation (AA):

TB = Trip Blank
FB = Field Blank
RB = Equipment Rinsate Blank (if necessary)
FD = Field Duplicate

Sample Depth (NNNN)

For surface and subsurface soil samples, the soil sample depth will be indicated by a four-digit number. The first two digits will represent the upper limit of the sample depth interval (rounded to the nearest foot), and the second two digits will represent the lower limit of the depth interval (e.g., 32SS-DW01-0002).

Sample Label Notes:

The names of all planned sample locations are identified in Worksheet No. 18.

Sample Location label (AA) will be used for non-Decision Unit surface soil and subsurface soil samples from Drainage Way-DW and Gasoline AST -ST; DW and ST samples will also include a sample number-NN and depth-NNNN (e.g., 32SS-DW0-0002). Sample Number (NN) only for surface soil, subsurface soil, sediment, and groundwater samples (e.g. 32SS-34-0002)

Sediment samples will be assigned a two-digit consecutive number in the order of collection (e.g., 32SD-01). Groundwater samples will be identified by the groundwater temporary well ID (e.g., 32GW-01).

QC Sample Number Notes:

All QC samples will be assigned a sequential sample number based on the QC sample type and the date of collection. For example, the first trip blank of the day collected on February 1, 2010 and associated with a surface soil would be assigned the tracking number 32SS-TB020110-01. Field duplicate, MS, and MSD samples will be collected from the same location as the original sample. The field duplicate will be given the same type of sample designation as the samples so that it will be "blind" to the laboratory (e.g., 32SB-FD020310-01 would be the first subsurface soil field duplicate sample collected on February 3, 2010). The sampling time recorded on the chain-of-custody form, labels and tags for the duplicate samples will be 0000. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

All pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets where appropriate.

SAP Worksheet No. 28 -- Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix	Soil/Sediment/ Groundwater and Aqueous Field QC Samples
Analytical Group	Select VOCs
Analytical Method/ SOP Reference	SW-846 8260B Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Trip Blank	One per cooler of VOC samples shipped to laboratory.	Must be < ½ QL, except common lab contaminants, which must be < QL.	No corrective action by laboratory.	None	Accuracy / Bias Contamination	Must be < ½ QL, except common lab contaminants, which must be < QL.
Method Blank	One per batch of 20 samples or less per matrix.	Must be <½ QL and <1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater), except common lab contaminants, which must be < QL.	Re-clean, retest, re-extract, reanalyze. If reanalysis cannot be performed, qualify data.	Analyst, Laboratory Supervisor	Accuracy / Bias Contamination	Must be <½ QL and <1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater), except common lab contaminants, which must be < QL.
System Monitoring Compounds (SMC)/ Surrogates	All field and QC samples.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).
Laboratory Control Sample (LCS)	One per batch of 20 samples or less per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Evaluate and reanalyze, if possible. If an MS/MSD was performed in the same 12-hour clock and acceptable, narrate. If the LCS recoveries are high, but the sample results are <QL, narrate; otherwise, re-prepare and reanalyze.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).

Matrix	Soil/Sediment/ Groundwater and Aqueous Field QC Samples
Analytical Group	Select VOCs
Analytical Method/ SOP Reference	SW-846 8260B Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Laboratory Control Sample Duplicate (LCSD) (Not Required)	One per batch of 20 samples or less per matrix, if analyzed.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤ 30%.	Evaluate and reanalyze, if possible. If an MS/MSD was performed in the same 12-hour clock and acceptable, narrate. If the LCS recoveries are high, but the sample results are <QL, narrate; otherwise, re-prepare and reanalyze.	Analyst, Laboratory Supervisor	Accuracy / Bias Precision	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤ 30%.
Internal Standards (ISs)	Every field sample, standard, and QC sample.	Retention times for IS must be within ± 30 seconds and the responses within -50% to +100% of ICAL mid-point standard.	Inspect MS or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Supervisor	Accuracy / Bias	Retention times for IS must be within ± 30 seconds and the responses within -50% to +100% of ICAL mid-point standard.
MS	One per batch of 20 samples or less per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Corrective action will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC. Examine the project DQOs and contact the client.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).
MSD	One per batch of 20 samples or less per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤ 30%.	Corrective action will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC. Examine the project DQOs and contact the client.	Analyst, Laboratory Supervisor	Accuracy / Bias Precision	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤ 30%.

Matrix	Soil/Sediment/ Groundwater and Aqueous Field QC Samples
Analytical Group	Select SVOCs (SIM)
Analytical Method/ SOP Reference	SW-846 8270C Empirical SOP-231 (SIM)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Method Blank	One per batch of 20 or fewer samples per matrix.	Must be <½ QL and < 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater), except common lab contaminants, which must be < QL.	Re-clean, retest, re-extract, reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor	Accuracy / Bias Contamination	Must be <½ QL and < 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater), except common lab contaminants, which must be < QL.
SMCs	All field and QC samples.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).
LCS	One per batch of 20 or fewer samples per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Evaluate and reanalyze, if possible. If an MS/MSD was performed in the same 12 hour clock and acceptable, narrate. If the LCS recoveries are high, but the sample results are <QL, narrate; otherwise, re-prepare and reanalyze.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).
IS	Every field sample, standard, and QC sample.	Retention times for IS must be within ± 30 seconds and the responses within -50% to +100% of ICAL mid-point standard.	Inspect MS or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Laboratory Supervisor	Accuracy / Bias	Retention times for IS must be within ± 30 seconds and the responses within -50% to +100% of ICAL mid-point standard.

Matrix	Soil/Sediment/ Groundwater and Aqueous Field QC Samples
Analytical Group	Select SVOCs (SIM)
Analytical Method/ SOP Reference	SW-846 8270C Empirical SOP-231 (SIM)

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
MS	One per batch of 20 or fewer samples per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).	Corrective action will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC. Examine the project DQOs and contact the client.	Analyst, Laboratory Supervisor	Accuracy / Bias	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B).
MSD	One per batch of 20 or fewer samples per matrix.	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤30%.	Corrective action will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, re-prepare the samples and QC. Examine the project DQOs and contact the client.	Analyst, Laboratory Supervisor	Accuracy / Bias Precision	DoD QSM QC acceptance criteria, if available. Otherwise, laboratory statistically derived %R limits (Appendix B). RPD ≤30%.

Matrix	Sediment
Analytical Group	TOC
Analytical Method/ SOP Reference	SW-846 9060 Lloyd Kahn Empirical SOP-221

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Method Blank	One per batch of 20 or fewer samples per matrix.	Must be < QL.	Re-clean, retest, re-extract, reanalyze, and/or qualify data.	Analyst, Laboratory Supervisor	Accuracy / Bias Contamination	Must be < QL.
LCS	One per batch of 20 or fewer samples per matrix.	%R must be within 90-110% of the true value.	Re-prepare and reanalyze samples.	Analyst, Laboratory Supervisor	Accuracy / Bias	90-110 %R.
MS	One per batch of 20 or fewer samples per matrix.	%R must be within 75-125% of the true value, if sample <4x spike added.	Narrate.	Analyst, Laboratory Supervisor	Accuracy / Bias	75-125 %R, if >4x spike added.
Laboratory Duplicate	One per batch of 20 or fewer samples per matrix.	%RPD $\leq$ 20%.	Narrate.	Analyst, Laboratory Supervisor	Precision	RPD ≤20%, if result >10x MDL; else, <±QL.

SAP Worksheet No. 29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Field Documents Field Logbook Field Sample Forms Chain-of-Custody Records Air Bills Sampling Instrument Calibration Logs Sampling Notes Drilling Logs Photographs FTMR Forms This SAP Health and Safety Plan	Field documents will be maintained in the project file located in the Tetra Tech project office.
Laboratory Documents Sample Receipt, Custody, and Tracking Records Standards Traceability Logs Equipment Calibration Logs Sample Preparation Logs Analysis Run Logs Equipment Maintenance, Testing, and Inspection Logs Corrective Action Forms Reported Field Sample Results Reported Results for Standards, QC Checks, and QC Samples Sample Storage and Disposal Records Telephone Logs Extraction/Clean-up Records Raw Data Data Completeness Checklist	Laboratory documents will be included in the hard-copy and Portable Document Format (PDF) deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech project file and in long-term data package storage at a third-party professional document storage firm. Electronic data results will be maintained in a database on a password-protected Structured Query Language (SQL) server.
Assessment Findings Field Sampling Audit Checklist (if conducted) Analytical Audit Checklist (if conducted) Data Validation Memoranda (includes tabulated data summary forms)	All assessment documents will be maintained in the Tetra Tech project file.
Reports Phase I RFI Report, SWMU 32	All versions of the SWMU 32 Phase I RFI Report and all support documents (e.g., data validation memoranda) will be stored in hard-copy in the Tetra Tech project file and electronically in the server library.

Procedures for data handling, management, tracking, and control are described in Section 29.0 below.

29.0 DATA HANDLING, MANAGEMENT, TRACKING, AND CONTROL

Data Handling and Management - After the field investigation is completed, the field sampling log sheets will be organized by date and medium and filed in the project files. The field logbooks for this project will be used only for this site and will also be categorized and maintained in the project files after the completion of the field program. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity. The data handling procedures to be followed by the laboratory(s) will meet the requirements of the technical specifications. The electronic data results will be automatically downloaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

Data Tracking and Control - The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- **Data Tracking.** Data is tracked from its generation to its archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to the analytical laboratory(s). Upon receipt of the data packages from the analytical laboratory(s), the Tetra Tech Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by the analytical laboratory(s).

- **Data Storage, Archiving, and Retrieval.** The data packages received from the analytical laboratory(s) are tracked in the data validation logbook. After the data are validated, the data packages are entered into the Tetra Tech Navy CLEAN file system and archived in secure files. The field records including field log books, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. The project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Tetra Tech.

- **Data Security.** The Tetra Tech project files are restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data Manager maintains the electronic data files. Access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

SAP Worksheet No. 30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization (name and address, contact person and telephone number)
Surface Soil, Subsurface Soil, and Sediment	Select VOCs	See Worksheet No. 18	SW-846 8260B SOP-202	21 days	Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 Contact: Janice Shilling Laboratory PM 615-345-1115	NA
	Select SVOCs	See Worksheet No. 18	SW-846 8270C SIM SOP-231/329	21 days		
Sediment	TOC	See Worksheet No. 18	SW-846 9060 SOP-221	21 days		
Aqueous	Select VOCs	See Worksheet No. 18	SW-846 8260B SOP-202	21 days		
	Select SVOCs	See Worksheet No. 18	SW-846 8270C SIM SOP-231/300	21 days		

SAP Worksheet No. 31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of Corrective Action (title and organizational affiliation)
Health and Safety	One per contract year	Internal	Tetra Tech	Health and Safety Personnel, Tetra Tech	PM, Tetra Tech	Auditor and HSM, Tetra Tech	HSM, Tetra Tech
Laboratory Systems Audit[1]	Every 3 years	External	DoD ELAP	DoD ELAP Accrediting Body Auditor	Laboratory QAM, Empirical	Laboratory QAM, Empirical	Laboratory QAM, Empirical
Field Progress Reports	Daily	Internal	Tetra Tech	FOL, Tetra Tech	FOL, Tetra Tech	FOL and Field Crew, Tetra Tech	FOL, PM, and QAM, Tetra Tech
Field Quality Assurance	One per contract year	Internal	Tetra Tech	Auditor, Tetra Tech	PM, Tetra Tech	Auditor and QAM, Tetra Tech	QAM, Tetra Tech

1 Empirical has successfully completed the laboratory evaluation process required as part of the DoD Environmental Laboratory Approval Program (ELAP) certification. A copy of the DoD ELAP certification letter is included in Appendix B.

SAP Worksheet No. 32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Time Frame for Response
Field Supervision	Site log book and sample collection logs	Tony Klimek, PM, Tetra Tech; George Ten Eyck, FOL, Tetra Tech	Immediately – on the same day	Entry in site logbook	Tony Klimek, PM, Tetra Tech; George Ten Eyck, FOL, Tetra Tech	24 hours
Health and Safety Audit	Audit checklist and written audit finding summary	Tony Klimek, PM, Tetra Tech; George Ten Eyck, FOL, Tetra Tech; John Trepanowski, Program Manager; and Garth Glenn, Deputy Program Manager, Tetra Tech	Dependant on findings; if major, a stop work order maybe issued immediately; however, if minor, within 1 week of audit	Written memo	Matt Soltis, HSM, Tetra Tech; TBD, Field Auditor, Tetra Tech; John Trepanowski, Program Manager, Tetra Tech; and Garth Glenn, Deputy Program Manager, Tetra Tech	Within 48 hours of notification
Field Sampling System Audit	Audit checklist and written audit finding summary	Tony Klimek, PM, Tetra Tech; George Ten Eyck, FOL, Tetra Tech; John Trepanowski, Program Manager; and Garth Glenn, Deputy Program Manager, Tetra Tech	Dependant on findings; if major, a stop work order maybe issued immediately; however, if minor, within 1 week of audit	Written memo	Tom Johnston, CLEAN QAM, Tetra Tech; Designee, Field Auditor, Tetra Tech; John Trepanowski, Program Manager, Tetra Tech; and Garth Glenn, Deputy Program Manager, Tetra Tech	Within 48 hours of notification
Laboratory System Audit	Written audit report	Randy Ward, Laboratory QA Manager, Empirical	Not specified by DoD ELAP	Letter	DoD ELAP Accrediting Body	Specified by DoD ELAP Accrediting Body

SAP Worksheet No. 33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Data Validation Report	Per SDG	Within 3 weeks after receiving the data from the laboratory	Project Chemist or Data Validator, Tetra Tech	PM, Tetra Tech; project file
Major Analysis Problem Identification (Internal Memorandum)	When persistent analysis problems are detected	Immediately upon detection of problem – on the same day	QAM, Tetra Tech	PM, Tetra Tech; QAM, Tetra Tech; Program Manager, Tetra Tech; project file
Project Monthly Progress Report	Monthly for duration of the project	Monthly	PM, Tetra Tech	PM, Tetra Tech; QAM, Tetra Tech; Program Manager, Tetra Tech; project file
Field Progress Report	Daily, oral, during the course of sampling	Every day that field sampling is occurring	FOL, Tetra Tech	PM, Tetra Tech
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem – on the same day	Laboratory PM, Empirical	PM, Tetra Tech; project file

SAP Worksheet No. 34 -- Verification (Step I) Process Table

(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Chain-of-Custody Forms	The Tetra Tech FOL or designee (sampler) will review and sign each chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and that the sample information is accurate. The chain-of-custody forms will be signed by the sampler, and a copy will be retained for the project file, Tetra Tech PM, and data validator. See SOP-04 (Appendix A).	Internal	FOL and Field Crew, Tetra Tech
	The laboratory sample custodian will review the sample shipment for completeness and integrity and will sign accepting the shipment. The data validator will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the laboratory sample custodian receiving the samples for analyses.	Internal/ External	1 - Laboratory Sample Custodian, Empirical 2 – Project Chemist or Data Validator, Tetra Tech
Sample Tables	Proposed samples verified to have been collected.	Internal	FOL and Field Crew, Tetra Tech
Sample Log Sheets	Log sheets completed as samples are collected in the field are verified for completeness and are maintained at the project office.	Internal	PM, FOL, or designee, Tetra Tech
Sample Coordinates	Sample locations will be verified to be correct and in accordance with the SAP (compare maps of proposed locations to maps of actual locations).	Internal	PM, FOL, or designee, Tetra Tech
Field QC Samples	Verify that field QC samples listed in Worksheet No. 20 were collected as required.	Internal	FOL or designee, Tetra Tech
Analytical Data Packages	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory QAM will sign the case narrative for each data package.	Internal	Laboratory QAM, Empirical
	Verify that the data package contains all the elements required by the functional guidelines and scope of work. Missing information will be requested from the laboratory and validation will be suspended until missing data is received. This occurs as part of the data validation process.	External	Project Chemist or Data Validator, Tetra Tech
Electronic Data Deliverables	The electronic data will be compared to the chain-of-custody form and hard-copy data package to verify accuracy and completeness.	External	Project Chemist or Data Validator, Tetra Tech

SAP Worksheet No. 35 -- Validation (Steps IIa and IIb) Process Table

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Field SOPs/Field Logs/Sample Collection	Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved, particularly that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken chain of custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the SAP was implemented and carried out as written and that any deviations are documented.	PM, FOL, or designee, Tetra Tech
IIa	Analytical SOPs	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.	Laboratory QAM, Empirical
IIa	Documentation of Method QC Results	Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the laboratory will contact the Tetra Tech PM for guidance prior to report preparation.	Laboratory QAM, Empirical
IIa	Chain-of-Custody Forms	Ensure that the custody and integrity of the samples were maintained from collection to analysis and that custody records are complete and any deviations are recorded.	Project Chemist or Data Validator, Tetra Tech
IIa	Holding Times	Verify that the samples were shipped and store at the required temperature and that the sample pH values for chemically preserved samples meet the requirements listed in Worksheet No. 19. Verify that the analyses were performed within the holding times listed in Worksheet No. 19.	Project Chemist or Data Validator, Tetra Tech
IIa	Data Results	Verify that the summary form results match the raw data.	Project Chemist or Data Validator, Tetra Tech
IIa/IIb	Laboratory Data Results for Accuracy	Ensure that the laboratory QC samples listed in Worksheet No. 28 were analyzed and that the MPCs listed in Worksheet No. 12 were met for all field samples and QC analyses. Verify that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Project Chemist or Data Validator, Tetra Tech

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa/IIb	Field and Laboratory Duplicate Analyses for Precision	Verify the field sampling precision by checking the RPD for field duplicate samples. Verify laboratory precision by checking RPDs or %D values from laboratory duplicate, MS/MSD, and LCS/LCSD analyses. Ensure compliance with the methods and project MPC accuracy goals listed in Worksheet No. 12.	Project Chemist or Data Validator, Tetra Tech
IIa/IIb	Sample Results for Representativeness	Verify that the laboratory recorded the temperature of each sample at sample receipt and the pH of chemically preserved samples to ensure sample integrity from sample collection to analysis.	Project Chemist or Data Validator, Tetra Tech
IIa/IIb	Project Screening Levels	Discuss the impact of matrix interferences or sample dilutions performed, because of the high concentration of one or more contaminants, on the other target compounds reported as not detected. Document this usability issue and inform the Tetra Tech PM.	Project Chemist or Data Validator, Tetra Tech
	Project Screening Levels	Review and add PSLs to the laboratory electronic data deliverable. Flag samples and notify the Tetra Tech PM of samples that exceed the PSLs as listed in Worksheet No. 15.	PM or designee, Tetra Tech
IIa/IIb	Data Validation Report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all data qualifications. Print a copy of the project database, qualified data depicting data qualifiers, and data qualifiers codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.	Project Chemist or Data Validator, Tetra Tech
IIa, IIb	SAP QC Sample Documentation	Verify that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Verify that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the laboratory shall have contacted the Tetra Tech Project Chemist or Tetra Tech PM.	Project Chemist or Data Validator, Tetra Tech

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa, IIb	Documentation of Analytical Reports for Completeness	Ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. Verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed in accordance with Worksheet No. 36. Verify all data have been transferred correctly and completely to the final SQL database.	Project Chemist or Data Validator, Tetra Tech
IIb	Project Quantitation Limits for Sensitivity	Verify that the QLs listed in Worksheet No. 15 were achieved.	Project Chemist or Data Validator, Tetra Tech
IIb	Analytical Data Deviations	Determine the impact of any deviation from sampling or analytical methods, SOP requirements, and matrix interferences on the analytical results.	Project Chemist or Data Validator, Tetra Tech

SAP Worksheet No. 36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	Surface and Subsurface Soil, Sediment, and Groundwater	Select VOCs	A full (Level IV) data validation will be performed using criteria for SW-846 8260B listed in Worksheets Nos. 12, 15, 24, 25, and 28, and the DoD QSM. If not included in the aforementioned, the logic outlined in the USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540/R-08-01 (June 2008) will be used to apply qualifiers to data.	Project Chemist or Data Validator, Tetra Tech
IIa and IIb	Surface and Subsurface Soil, Sediment, and Groundwater	Low Level PAHs	A full (Level IV) data validation will be performed using criteria for SW-846 8270C-modified (SIM) listed in Worksheets Nos. 12, 15, 24, 25, and 28, and the DoD QSM. If not included in the aforementioned, the logic outlined in the USEPA CLP National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540/R-08-01 (June 2008) will be used to apply qualifiers to data.	Project Chemist or Data Validator, Tetra Tech
IIa and IIb	Sediment	TOC	A full (Level IV) data validation will be performed using criteria for SW-846 9060 listed in Worksheets Nos. 12, 15, 24, 25, and 28, and the DoD QSM. If not included in the aforementioned, the logic outlined in the USEPA Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses (1993) will be used to apply qualifiers to data.	Project Chemist or Data Validator, Tetra Tech

SAP Worksheet No. 37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment
The usability of the data directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum, and the results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics: • **Completeness** For each matrix that was scheduled to be sampled, the Tetra Tech FOL acting on behalf of the Tetra Tech Project Team will prepare a table listing planned samples/analyses compared to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions. • **Precision** The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheet Nos. 12 and 28. This will also include a comparison of field and laboratory precision with the expectation that field duplicate results will be no less precise than laboratory duplicate results. If the goals are not met, or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report. **Accuracy** The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in Worksheet No. 28. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, MSs, and LCSs. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report. • **Representativeness** A Tetra Tech Project Scientist identified by the Tetra Tech PM and acting on behalf of the Project Team will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Scientist indicates that a quantitative analysis is required. • **Comparability** The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech Project Chemist indicates that such quantitative analysis is

required.

- **Sensitivity**
  The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether project sensitivity goals listed in Worksheet No. 15 were achieved. The overall sensitivity and QLs from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described. The Tetra Tech Project Chemist may enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

- **Project Assumptions and Data Outliers**
  The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include assumptions related to data distributions (e.g., normal or log-normal) and estimates of data variability. Potential data outliers will be removed if a review of the associated data indicates that the results have an assignable cause that renders them inconsistent with the remainder of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After the completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these DQI characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples with non-detected results, number of samples with detected results, and the proportion of samples with detected and non-detected results. The Project Team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. The Project Team will consider whether any missing or rejected data have compromised the ability to make decisions or to make decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated for by other data. Although rejected data will generally not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to one-half of the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations; however, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the NSA Crane ERSM, Navy RPM, IDEM RPM, and USEPA RPM. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or a teleconference, depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary.

REFERENCES

ATEC Environmental Consultants. 1989. Preliminary Fuel Oil Containment Study, Tank Farm near Building 2760. Crane Naval Weapons Supply Center. Crane, Indiana. Report for PEDCO E and A Services. June.

Department of the Navy, Crane Division, Naval Surface Warfare Center. 1999. Tank Farm Demolition and Cleanup.

Howard, Needles, Tammen, and Bergendoff. 1993. Site Remediation Study, Tank Farm. Report for Crane Division Naval Surface Warfare Center. Crane, Indiana. March.

IDEM (Indiana Department of Environmental Management). 2001. Risk Integrated System of Closure (RISC) User's Guide. February.

IDEM, 2009. RISC Residential Closure Levels for Soil. Appendix 1, Default Closure Level Tables. Version 1.2. May.

IDQTF (Interagency Data Quality Task Force), 2005. Uniform Federal Policy for Quality Assurance Project Plans. Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Parts 1, 2A, 2B, and 2C. Final, Version 1. March.

OSHA (Occupational Safety and Health Administration) General Industry Standards, Chapter 29, Code of Federal Regulations (CFR) 1910.120.

PEDCo, E and A Services, Inc. 1989. Tank Farm Study for Crane Naval Weapons Support Center. Crane, Indiana. Report for Crane Naval Weapons Support Center. July.

SAIC (Science Applications International Corporation). 2000. Environmental Monitoring Report for the Tank Farm at Crane Division Naval Surface Warfare Center. September.

Sverdrup Environmental, Inc. 1997a. Work Performed, Tank Farm. Crane Surface Warfare Center, Crane Division. Crane, Indiana. Storage Tank Removal and Installation Program. July.

Sverdrup Environmental, Inc. 1997b. Closure Report, Tank Farm Decontamination. Crane Surface Warfare Center, Crane Division. Crane, Indiana. Storage Tank Removal and Installation Program. October.

Tetra Tech (Tetra Tech NUS, Inc.), 2001. Final Base-Wide Background Soil Investigation Report for Naval Surface Warfare Center Crane, Crane, Indiana. January.

Tetra Tech. 2008. Site-Specific Health and Safety Plan for NSWC Crane.

USDoD (United States Department of Defense), 2006. Department of Defense Quality Systems Manual for Environmental Laboratories. Version 3. January.

USDoD, 2009. Department of Defense Quality Systems Manual for Environmental Laboratories. Version 4.1. April.

USEPA (United States Environmental Protection Agency), 1986. Test Methods for Evaluating Solid Waste; Physical/Chemical Methods (SW-846), 3rd Edition (including Update III). Office of Solid Waste and Emergency Response, Washington, DC.

USEPA, 1993. Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses. September.

USEPA. 2002a. Guidance for Quality Assurance Project Plans (EPA QA/G-5). EPA/240/R-02/009. USEPA Office of Environmental Information, Washington DC. December.

USEPA. 2002b. Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan (EPA QA/G-5S). EPA/240/R-02/005. USEPA Office of Environmental Information, Washington DC. December.

USEPA. 2003. Guidance for Developing Ecological Soil Screening Levels, Office of Solid Waste and Emergency Response, Directive 9285.7-55. November.

USEPA, 2005. Resource Conservation and Recovery Act Corrective Action Ecological Screening Levels, USEPA Region 5 (http://www.epa.gov/reg5rcra/ca/ edql.htm). August.

USEPA, 2006a. Guidance on Systematic Planning using the Data Quality Objectives Process. EPA QA/G-4, EPA/240/B-06/001. Office of Environmental Information, Washington DC. February.

USEPA, 2006b Region 3 Freshwater Sediment Screening Benchmarks (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm).

USEPA, 2006c Region 3 Freshwater Screening Benchmarks (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm).

USEPA, 2008a. Multi-year documents with Ecological Soil Screening Levels for individual chemicals. http://www.epa.gov/ecotox/ecossl/.

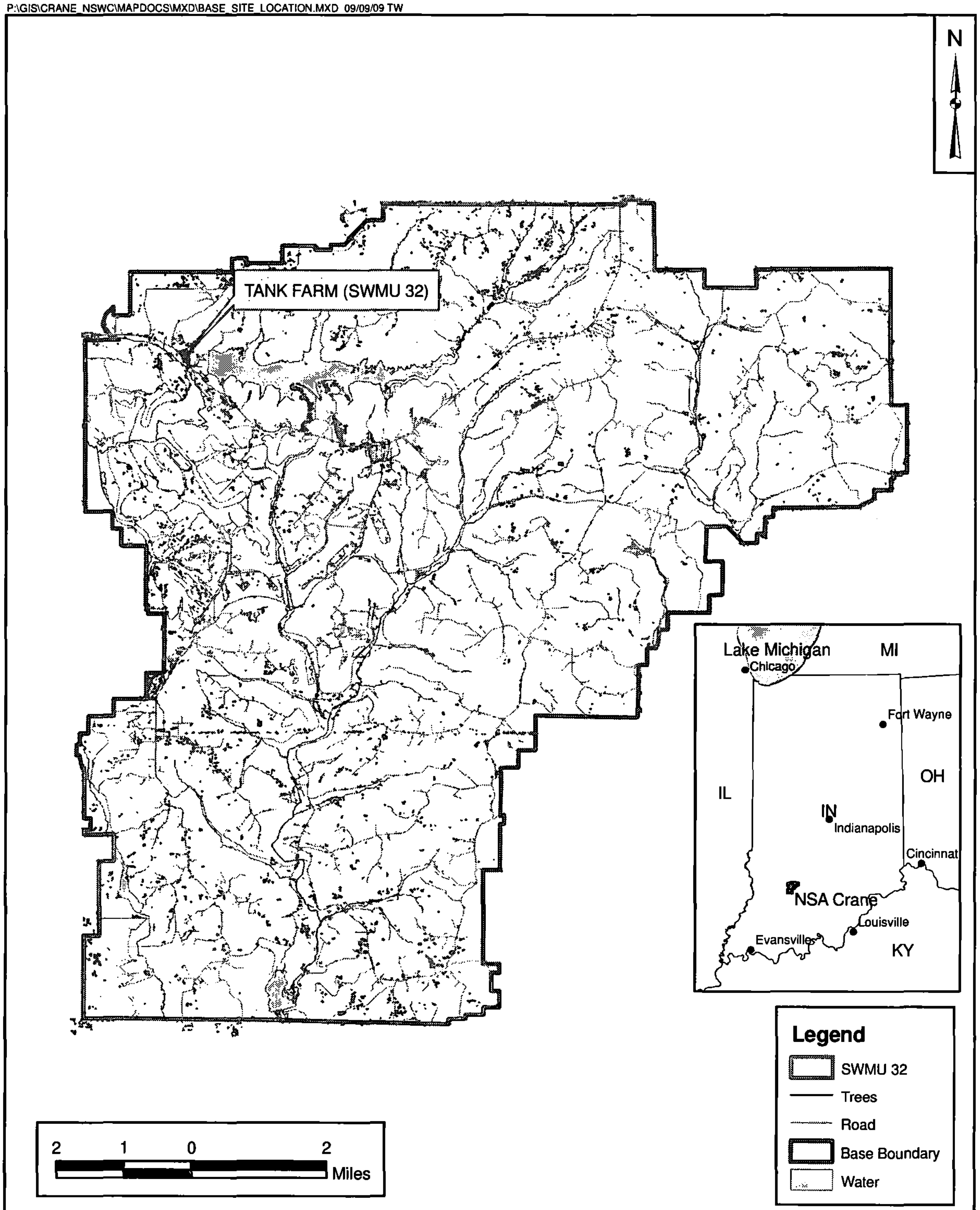
USEPA, 2008b. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540/R-08-01. June.

USEPA. 2009a. Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites. RSL Table Update. http://epa-prgs.ornl.gov/chemicals/index.shtml. May.

USEPA, 2009b. National Primary Drinking Water Regulations, Maximum Contaminant Levels, EPA-816-F-09-0004. http://www.epa.gov/safewater/consumer/pdf/mcl.pdf. May.

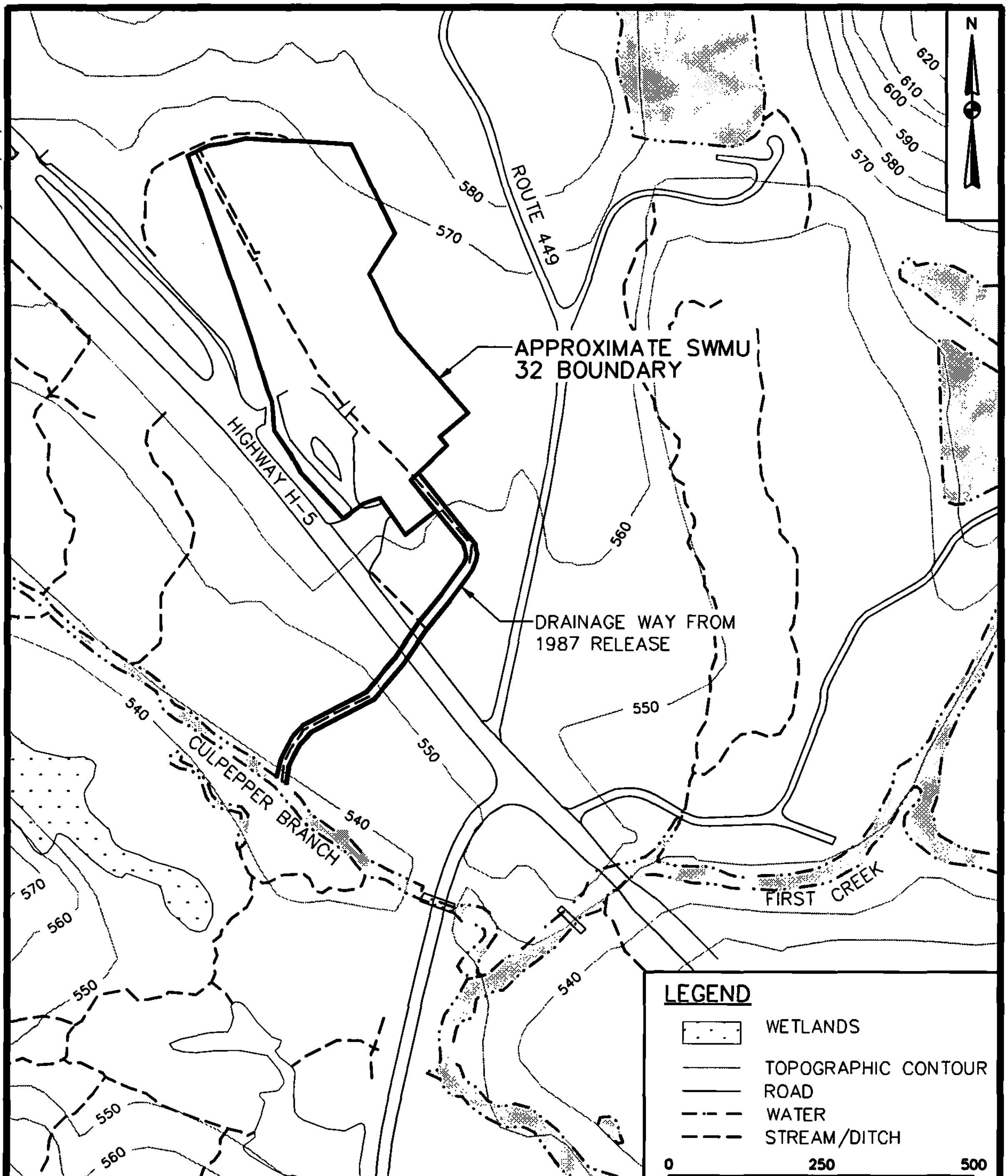
FIGURES

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\BASE_SITE_LOCATION.MXD 09/09/09 TW



DRAWN BY K. MOORE	DATE 04/15/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 271	
CHECKED BY L. FOSTER	DATE 09/09/09	BASE AND SITE LOCATION MAP SWMU 32 - FORMER FUEL OIL TANK FARM NSA CRANE CRANE, INDIANA	APPROVED BY	DATE
REVISED BY	DATE		APPROVED BY	DATE
SCALE AS NOTED			FIGURE NO. FIGURE 10-1	REV 0

ACAD: 2111CM07.dwg 09/09/09 CK PIT

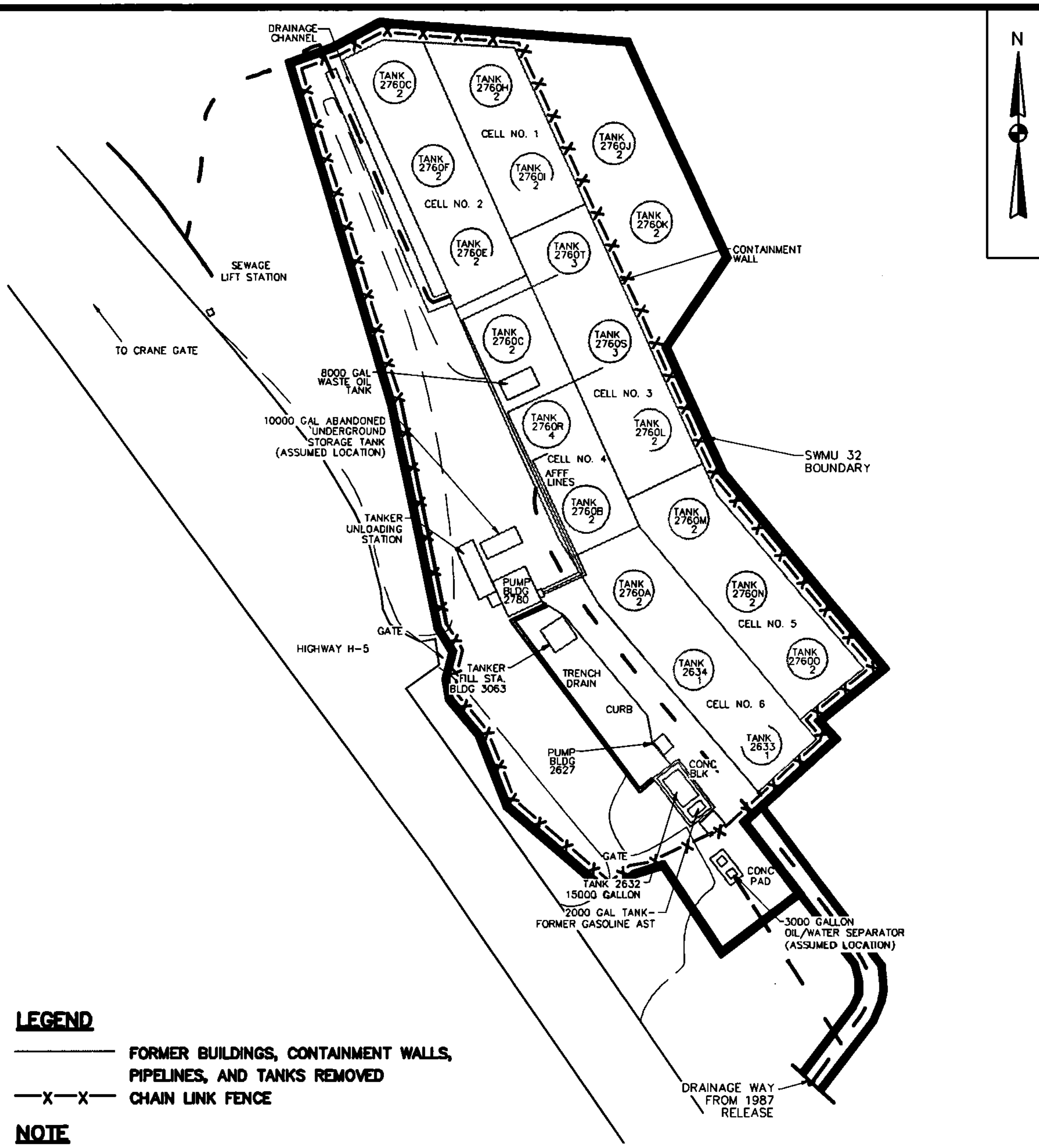


NOTE: APPROXIMATE SWMU BOUNDARY BASED ON TANK FARM SITE PLAN.

DRAWN BY CK / DATE 9/09/09	NAVFAC	SWMU 32–GENERAL LOCATION MAP SWMU 32 RFI NSA CRANE CRANE, INDIANA	CONTRACT NO. 2111
CHECKED BY / DATE			OWNER NO.
REVISED BY / DATE			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10–2 / REV. 0

FORM CADD NO. SDIV-AV.DWG – REV 1 – 9/10/98

ACAD:2111CM11.dwg 09/25/09 CK



LEGEND

——————— FORMER BUILDINGS, CONTAINMENT WALLS, PIPELINES, AND TANKS REMOVED

—x—x— CHAIN LINK FENCE

NOTE

ALL TANKS AND STRUCTURES REMOVED AND SITE REGRADED. ONLY CHAIN LINK FENCE REMAINS AS OF JUNE 2009.

0 120 240

SCALE: 1" = 120'

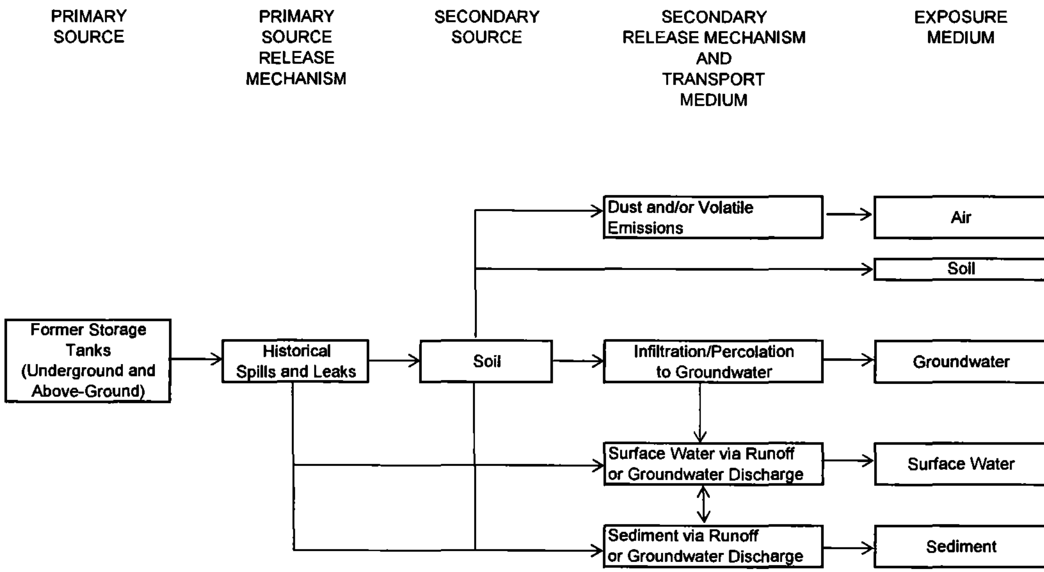
SOURCE; SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, 2000 ENVIRONMENTAL MONITORING REPORT FOR TANK FARM, CRANE DIVISION, NAVAL SURFACE WARFARE CENTER.

DRAWN BY CK	DATE 9/09/09	SWMU 32-SITE PLAN SWMU 32 - RFI NSA CRANE CRANE, INDIANA	CONTRACT NO. 2111
CHECKED BY	DATE		OWNER NO.
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10-3 / REV. 0

NAVFAC

FORM CADD NO. SDIV-AV.DWG - REV 1 - 9/10/98

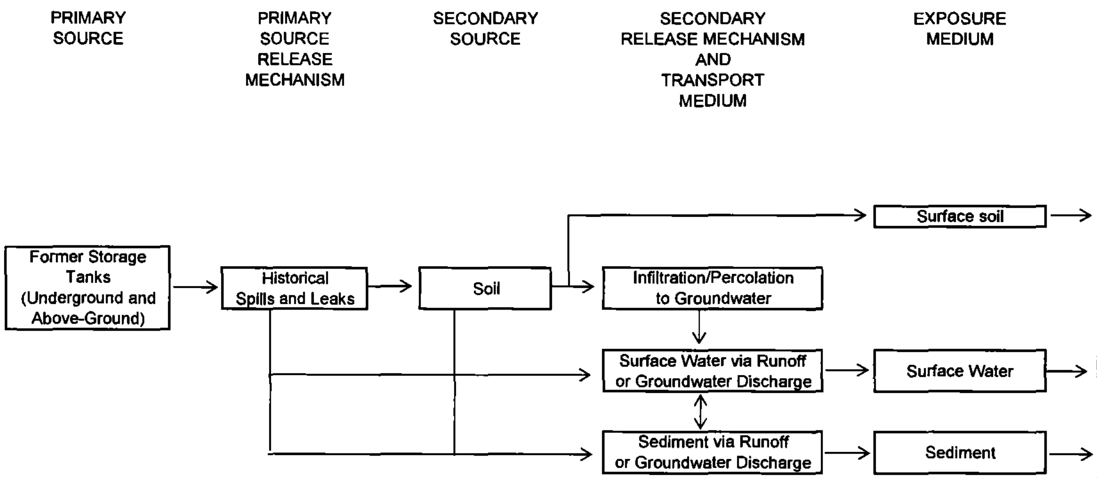
FIGURE 10.4
HUMAN CONCEPTUAL EXPOSURE MODEL DIAGRAM
SWMU 32 - FORMER FUELTANK FARM
NSA CRANE, INDIANA



EXPOSURE ROUTES	HUMAN RECEPTORS: CONSTRUCTION WORKER	MAINTENANCE WORKER	OCCUPATIONAL WORKER	ADOLESCENT TRESPASSER	RECREATIONAL USERS	ON-SITE RESIDENT
Inhalation	•	•	•	•	•	•
Ingestion	•	•	•	•	•	•
Dermal Contact	•	•	•	•	•	•
Ingestion						•
Dermal Contact	•					•
Inhalation of Volatiles	•					•
Vapor Intrusion in Buildings			•			•
Ingestion of Surface Water				•	•	
Dermal Contact with Surface Water				•	•	
Ingestion of Sediment				•	•	
Dermal Contact with Sediment				•	•	

• Indicates receptor for evaluation

FIGURE 10-5
ECOLIGICAL CONCEPTUAL EXPOSURE MODEL DIAGRAM
SWMU 32 - FORMER TANK FARM
NSA CRANE, INDIANA

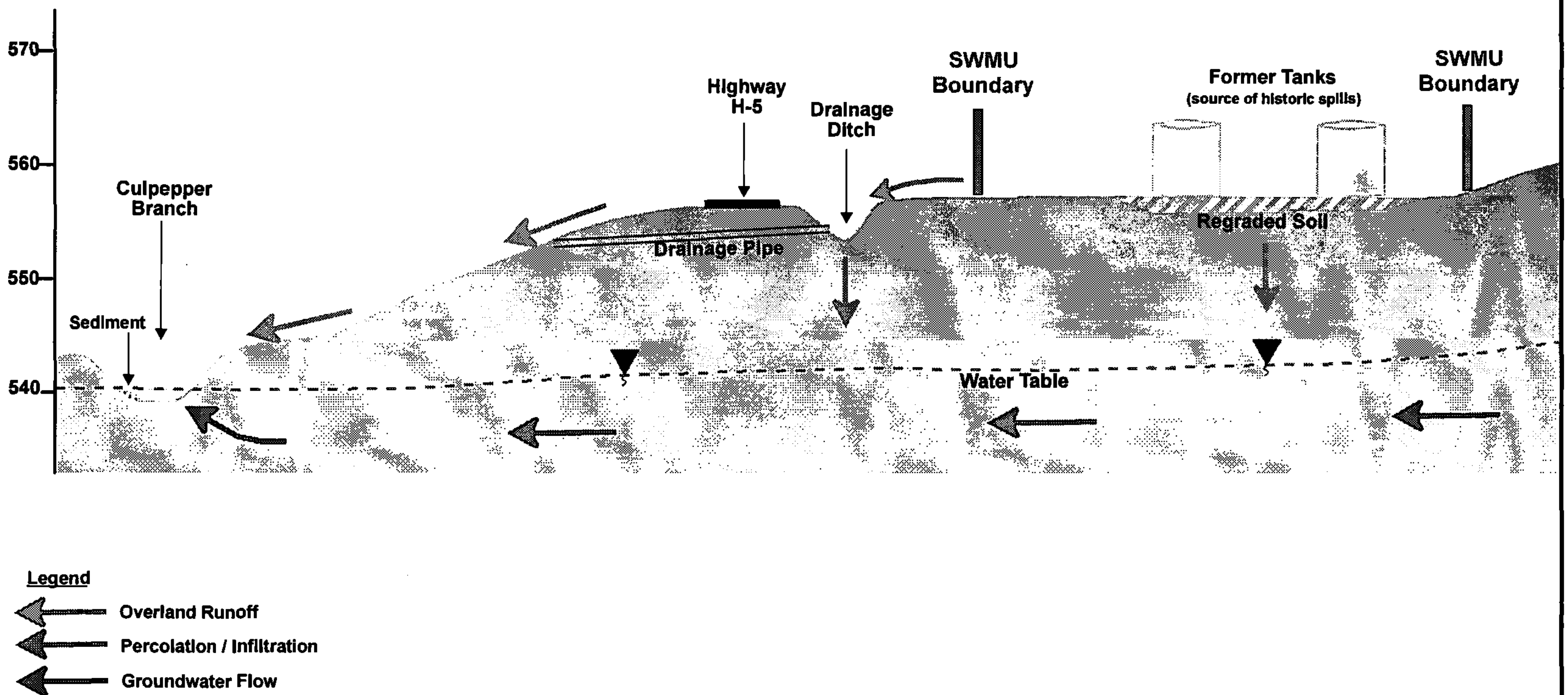


EXPOSURE ROUTES	TERRESTRIAL VERTEBRATES	TERRESTRIAL INVERTEBRATES	AQUATIC VERTEBRATES	AQUATIC INVERTEBRATES	TERRESTRIAL PLANTS
Direct Contact	•	•			•
Ingestion of Soil	•	•			
Ingestion of Plants	•	•			
Ingestion of Prey	•	•			
Direct Contact	•		•	•	
Ingestion of Surface Water	•		•	•	
Ingestion of Prey	•		•	•	
Direct Contact	•		•	•	
Ingestion of Sediment	•		•	•	
Ingestion of Prey	•		•	•	

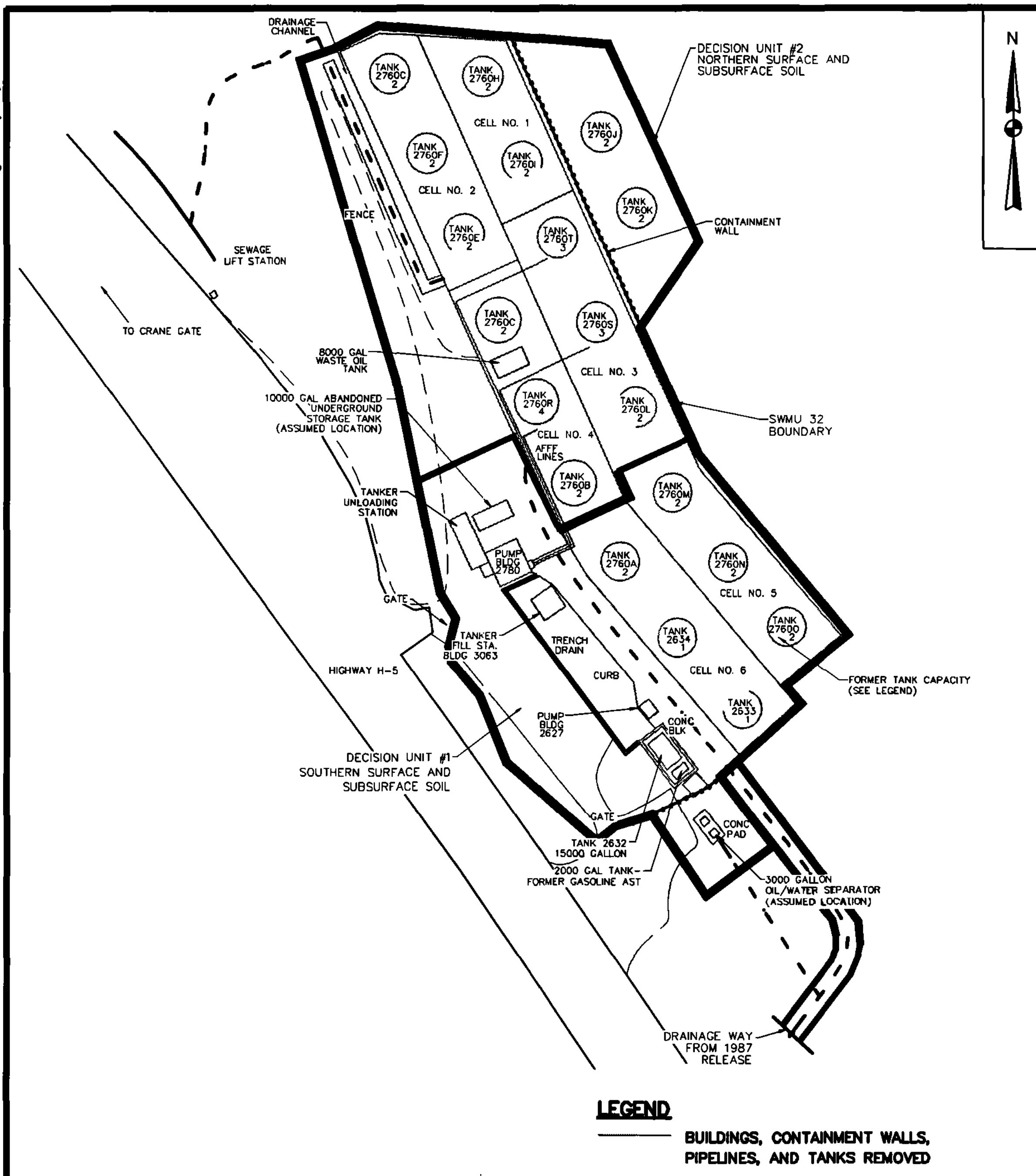
ECOLOGICAL RECEPTORS

• Indicates receptor for evaluation

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMW32_CONCEPTUAL_SITE_MODEL.MXD MM 9/23/09



DRAWN BY M. MAGUIRE	DATE 09/25/09	CONCEPTUAL SITE MODEL SCHEMATIC	CONTRACT NUMBER —
CHECKED BY T. KLIMEK	DATE 09/25/09	SWMU 32	APPROVED BY — DATE —
REVISED BY —	DATE —	NSA CRANE	APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC	CRANE, INDIANA	FIGURE NO. FIGURE 10-6 / REV 0

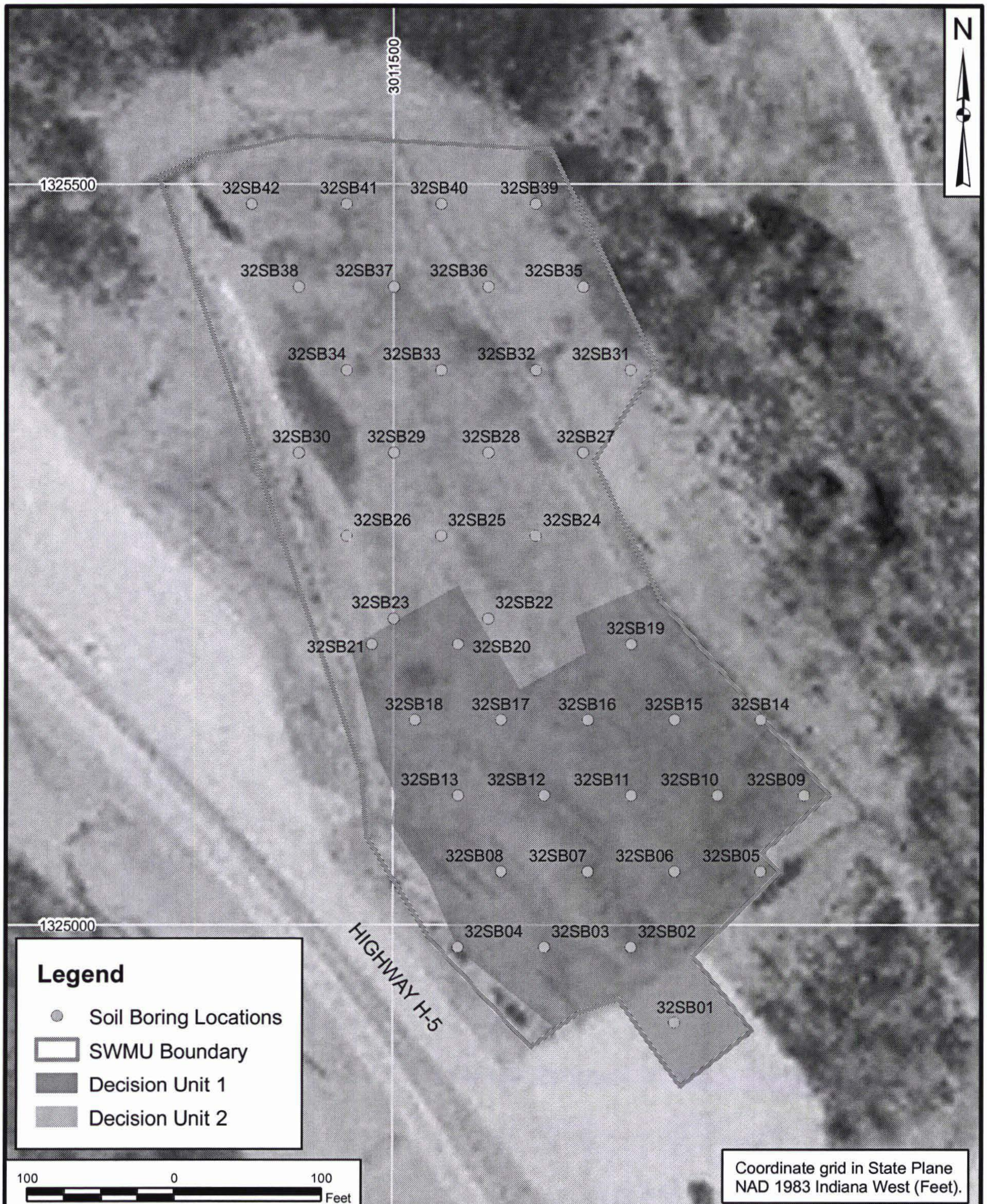


SOURCE: SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, 2000 ENVIRONMENTAL MONITORING REPORT FOR TANK FARM, CRANE DIVISION, NAVAL SURFACE WARFARE CENTER.

DRAWN BY CK	DATE 9/09/09	NAVFAC	SWMU 32 DECISION UNIT BOUNDARIES SWMU 32 – RFI NSA CRANE CRANE, INDIANA	CONTRACT NO. 2111	
CHECKED BY	DATE			OWNER NO.	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 11-1	REV. 0

FORM CADD NO. SDIV-AV.DWG – REV 1 – 9/10/98

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU32_SB_LOCS.MXD 09/28/09 JEE



DRAWN BY J. ENGLISH	DATE 09/14/09	NAVFAC	DECISION UNITS 1 AND 2 - SOIL SAMPLE LOCATION MAP SWMU 32 RFI NSA CRANE CRANE, INDIANA	CONTRACT NUMBER ___
CHECKED BY L. FOSTER	DATE 09/28/09			APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___			APPROVED BY ___ DATE ___
SCALE AS NOTED				FIGURE NO. FIGURE 17-1 REV 0

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU32_SED_LOCS.MXD 09/24/09 JEE

DRAWN BY J. ENGLISH — DATE 09/14/09	NAVFAC	SEDIMENT SAMPLE AND NON-DECISION UNIT SOIL SAMPLE LOCATION MAP SWMU 32 RFI NSA CRANE CRANE, INDIANA	CONTRACT NUMBER
CHECKED BY L. FOSTER — DATE 09/24/09			APPROVED BY — DATE
REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			FIGURE NO. FIGURE 17-2 — REV 0

P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU32_GW_LOCS.MXD 10/29/09 SS

DRAWN BY	DATE			CONTRACT NUMBER	
J. ENGLISH	09/14/09	NAVFAC	GROUNDWATER MONITORING WELL LOCATION MAP SWMU 32 RFI NSA CRANE CRANE, INDIANA	___	
CHECKED BY	DATE			APPROVED BY	DATE
G. TEN EYCK	10/29/09			___	___
REVISED BY	DATE			APPROVED BY	DATE
___	___			___	___
SCALE AS NOTED				FIGURE NO. FIGURE 17-3	REV 0

APPENDIX A

FIELD STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURE

SOP-01

GLOBAL POSITIONING SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the Field Technicians with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing them to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. This SOP is specific to GIS quality data collection for Trimble-specific hardware and software.

If possible, the Trimble GeoXM or GeoXH Operators Manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf

Unless the operator is proficient in the setup and operation of the GPS unit, the Project Manager (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech NUS, Inc.
Attn: John Wright
661 Anderson Drive, Bldg #7
Pittsburgh, PA 15220

2.0 REQUIRED EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:

2.1 Required GPS Hardware

- Hand-held GPS Unit capable of sub-meter accuracy (i.e. Trimble GeoXM or Trimble GeoXH). This includes the docking cradle, a/c adapter, stylus, and USB cable for data transfer.

Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting Geo to range pole)
- GeoBeacon

- Indelible marker
- Non-metallic pin flags for temporary marking of positions

2.2 Required GPS Software

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)

- Microsoft ActiveSync version 4.2 or later. Download to personal computer from: http://www.microsoft.com/windowsmobile/en-us/downloads/eulas/eula_activesync45_1033.mspx?ProductID=76

- Trimble Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from: http://www.trimble.com/datatransfer.shtml

3.0 START-UP PROCEDURES

Prior to utilizing the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the far domed end in the top of the cradled, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

Start Up:

1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.

2) Utilizing the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.

3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.

4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

3.1 Confirm Setup Settings

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

1) Coordinate System
   a. Tap on the Coordinate System.
   b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu. **Note:** It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
   c. Tap on the Units.
   d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   e. Tap Real-time Settings.
   f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   g. The GPS unit is now configured correctly for your specific project.

4.0 ANTENNA CONNECTION

1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
2) At this point the GPS unit is ready to begin collecting data.

5.0 COLLECTING NEW DATA IN THE FIELD

1) From the Main Menu select Data.
2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
4) After entering the file name, tap Create to create the new file.
5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
6) The Choose Feature screen appears.

5.1 Collecting Features

1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
2) **<u>Do not</u> begin the data logging process until you are at the specific location for which you intend to log the data.**
3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
4) Upon arriving at the specific location, tap on Point_generic as the Feature Name.
5) Tap Create to begin data logging.
6) In the Comment Box enter sample ID or location-specific information.
7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
9) Repeat steps 2 through 8, giving each data point a unique name or number.

Note: If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

5.2 Viewing Data or Entering Additional Data Points to the Current File

1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/-> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

5.3 Viewing Data or Entering Data Points from an Existing File

1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
4) Highlight the file you want to view and select Map from the Main Menu.
5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

6.0 NAVIGATION

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

1) From the Main Menu select Map.
2) Using the Select tool, pick the point on the map to where you want to navigate.
3) The location you select will have a box placed around the point.
4) From the Options menu, choose the Set Nav Target (aka set navigation target).
5) The location will now have double blue flags indicating this point is you navigation target.
6) From the Main Menu select Navigation.

7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.
8) Follow the navigation guide until you reach the point you select.
9) Repeat as needed for any map point by going back to Step 1.

7.0 PULLING IN A BACKGROUND FILE

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

1) From the Main Menu select Map, then tap on Layers, select the background file from drop down list.
2) Select the project-specific background file from the list of available files.
3) Once the selected background file appears, the operator can manipulate the screen utilizing the +/- and <-/-> functions at the bottom of the screen.
4) In operating mode, the operator's location will show up on the background file as a floating "x".

8.0 DATA TRANSFER

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator can not download files, see the Note at the end of Section 8.0.

1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

Note: If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

9.0 SHUTTING DOWN

This section provides instruction for properly shutting down the GPS unit.

1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.

2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.
4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

ATTACHMENT A

How to Transfer Trimble GPS Data between Data Collector and PC
original 11/21/06 (5/1/08 update) – John Wright

Remember – Coordinate System, Datum, and Units are critical!!!

Trimble Data Collection Devices:
Standard rental systems include the Trimble ProXR/XRS backpack and the newer handheld GeoXT or GeoXH units. Some of the older backpack system may come with either a RECON "PDA-style" or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

Data Transfer:
Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft ActiveSync installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

• **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: http://www.trimble.com/datatransfer.shtml

• **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: http://www.microsoft.com/windowsmobile/activesync/default.mspx
(see page 2 for data transfer instructions)

To Transfer Data Collected in the Field:

• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Make sure the data file desired is CLOSED in TerraSync prior to transfer
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "***Receive***" data tab (under device)
• Select "***Data***" from file types on the right
• Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
• Select or browse to a C-drive folder you can put this file for emailing
• When the file appears on the list, hit the "***Transfer All***"
• Go to your Outlook or other email, send a message to: John.Wright@tetratech.com (or GIS department)
• Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):

• Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
• Contact John Wright (John.Wright@tetratech.com) if needed for file conversion and upload support
• The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "**Send**" data tab (under device)
• Select "**Data**" from file types on the right (you can also send background files)
• Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
• Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
• When the file(s) appears on the list, hit the "***Transfer All***"
• Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)

STANDARD OPERATING PROCEDURE

SOP-02

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)
Disposable medical-grade gloves (e.g. latex, nitrile)
Sample log sheets
Required sample containers: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory.
Sample labels
Chain-of-custody records
Sealable polyethylene bags
Heavy-duty cooler
Ice

3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be printed prior to mobilization to be used for field QC and backups.

- Project Number
- Sample Location ID
- Contract Task Order Number (CTO F273)
- Sample ID
- Matrix

- Preservative
- Analysis to be Performed
- Laboratory Name

3.2 Select the container(s) that are appropriate for a given sample. Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).

3.3 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.4 Place the sample container in a sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

4.0 ATTACHMENTS

1. Sample Label

ATTACHMENT 1
SAMPLE LABEL

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	**Project:** **Location:** **CTO:**	
Sample No:		**Matrix:**
Date:	**Time:**	**Preserve:**
Analysis:		
Sampled by:	**Laboratory**	

STANDARD OPERATING PROCEDURE

SOP-03

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Support Activity (NSA) Crane. The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of sample identification

The NSA Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Pen with indelible ink
Sample tags
Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Confirmation Samples

All confirmation samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

3.1.1 Confirmation Sample Numbering Scheme

The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated Solid Waste Management Unit (SWMU) number, sample type, location, and sample depth. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For sediment samples, the final four tracking numbers will identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

NN	**AA**	**AANN**	**NNNN (Soils and Sediment only)**
SWMU Number	Matrix	Sample Location Number	Sequential depth interval from freshly exposed surface

Character Type:

A = Alpha

N = Numeric

SWMU Number (NN):

32 = SWMU 32

Matrix Code (AA):

SS = Surface Soil Sample

SB = Subsurface Soil Sample

SD = Sediment Sample

GW = Groundwater Sample

SW = Surface Water Sample

Location Number (AANN):

Location ID (the AA portion) is optional (not all samples will have this code), sequential number beginning with "01" for each matrix. The location ID may contain two letters (e.g., DW for Drainage Way or ST for Storage Tank).

Depth Interval (NNNN):

This code section will be used for soil and sediment samples only. For soil samples, the final four tracking numbers will identify the depth in units of feet. Surface soil samples will be collected from 0- to 2-feet bgs. Subsurface soil samples will be collected at depths greater than 2-feet bgs. For sediment samples, the final four tracking numbers will identify the depth in units of inches. Sediment samples will be collected from 0- to 6-inches below the sediment/water interface.

The depth code is used to note the depth bgs at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval of the sample depth. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc

3.1.2 Examples of Sample Nomenclature

The first surface soil sample collected from the Drainage Way at SWMU 32, at a depth of 0- to 2-feet bgs would be labeled as "32SS-DW01-0002".

The sediment sample collected from sampling location 01 at SWMU 32 would be labeled as 32SD-01-0006.

3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the UFP-SAP. They will be designated using a different coding system than the one used for regular field samples.

3.2.1 QC Sample Numbering

The QC code will consist of a four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

NN	AA	AA	NNNNNN	NN
SWMU Number	Matrix	QC Type	Date	Sequence Number (per day)

The QC types are identified as:

TB = Trip Blank

RB = Rinsate Blank

FD = Field Duplicate

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be "0000" so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

3.2.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day at SWMU 32 for a surface soil sample collected on February 1, 2010 would be designated as 32SS-FD020110-01.

The second duplicate of the day taken at SWMU 32 of a subsurface soil sample collected on February 3, 2010 would be designated as 32SB-FD020310-02.

The first rinsate blank associated with surface soil samples collected on February 3, 2010 would be designated as 32SS-RB110309-01.

STANDARD OPERATING PROCEDURE
SOP-04

SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, labels, and equipment are required.

Writing utensil (preferably black pen with indelible ink)
Site logbook
Field logbook
Sample label
Chain-of-Custody Form
Custody seals
Equipment calibration log
Soil and Sediment Sample Log Sheet

3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

3.1 Site Logbook

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities and events will be recorded (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each site logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the Field Operations Leader (FOL).

3.2 Field Logbooks

The field logbook is a separate dedicated notebook used by field personnel to document his or her activities in the field. This notebook is hardbound and paginated.

3.3 Sample Labels

Adhesive sample container labels must be completed and applied to every sample container. Information on the label includes the project name, location, sample number, date, time, preservative, analysis, matrix, sampler's initials, and the name of the laboratory performing the analysis.

3.4 Chain-of-Custody Form

The Chain-of-Custody Form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. Each COC is numbered. This form must accompany any samples collected for laboratory chemical analysis. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the upper right hand corner section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page __ of __" on each COC. The original (top) signed copy of the COC will be placed inside a sealable polyethylene bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Project Manager (PM). The COC form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

3.5 Custody Seal

The custody seal is an adhesive-backed label, and it is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The custody seals are signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the TtNUS PM if evidence of tampering is observed.

3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

3.7 Sample Log Sheets

The Soil and Sediment Sample Log Sheets are used to document the sampling of soil and sediment (see SOPs-07, -08, and -09).

4.0 ATTACHMENTS

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log

ATTACHMENT 1
CHAIN-OF-CUSTODY RECORD

CHAIN OF CUSTODY | NUMBER | PAGE ____ OF ______

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
		CARRIER/WAYBILL NUMBER	CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR ____	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G) / PRESERVATIVE USED / TYPE OF ANALYSIS								COMMENTS

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME
COMMENTS					

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY) 3/99

FORM NO. TINUS-001

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : ____________________ INSTRUMENT NAME/MODEL: ____________________

SITE NAME: ____________________ MANUFACTURER: ____________________

PROJECT No.: ____________________ SERIAL NUMBER: ____________________

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

ATTACHMENT 2
EQUIPMENT CALIBRATION LOG

ATTACHMENT 3

SOIL AND SEDIMENT SAMPLE LOG SHEET

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: ____________________
[] QA Sample Type: ____________________

Sample ID No.: ____________________
Sample Location: ____________________
Sampled By: ____________________
C.O.C. No.: ____________________

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE

SOP-05

SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil, sediment, and aqueous samples.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Shipping labels
Custody seals
Chain-of-custody (COC) form(s)
Sample containers with preservatives: All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.
Sample shipping containers (coolers): All sample shipping containers are supplied by the laboratory.
Packaging material: Bubble wrap, sealable polyethylene bags, strapping tape, etc.

3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4 degrees Celcius (°C). This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.

3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure sensitive tape supplied with the bag.

3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Line the cooler with large plastic bag, and line the bottom of the cooler with a layer of bubble wrap. Place the sample containers into the shipping cooler in an upright position (containers will be upright, with the exception of any 40-milliliter vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.

3.7 Wrap the large plastic bag closed and secure with tape.

3.8 Place the original (top) signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler.

3.9 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.

3.10 Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.

3.11 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

STANDARD OPERATING PROCEDURE

SOP-06

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)
Non-latex rubber or plastic gloves
Cotton gloves
Field logbook
Potable water
Deionized water
Isoproponal (optional)
LiquiNox detergent
Brushes, spray bottles, paper towels, etc.
Container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the LiquiNox wash.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP-10 and this UFP-SAP.

STANDARD OPERATING PROCEDURE

SOP-07

SOIL CORING AND SAMPLING USING HAND AUGER TECHNIQUES

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using hand augering techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Disposable medical-grade gloves (e.g., latex, nitrile)
Writing utensil (preferably black pen with indelible ink)
Indelible marker
Stainless Steel Auger Buckets
Stainless Steel Extension Rods
Cross Handle
Required decontamination materials
Bentonite pellets
Sealable polyethylene bags
Sample labels
Shipping containers (containing ice)
Disposable plastic trowels or stainless steel trowels
Stainless steel mixing bowls
Sample containers: Sample containers are certified clean by the laboratory supplying the containers.
Soil Sample Log Forms
Daily Activity Logs
Chain-of-Custody Form

3.0 SOIL SAMPLING USING A HAND AUGER

Hand Augers may be employed to collect the soil cores. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), a cross handle.

3.1 The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence or rock layers and the collapse of the borehole normally contribute to its limiting factors.

Attach a properly decontaminated bucket bit into a clean extension rod and further attach the cross handle to the extension rod.

3.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, letter, etc.)

3.3. Turn the hand auger sampler into the ground to a depth of 6-inches. The 0- to 6-inch depth soil interval is considered to be the surface soil.

3.4 After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

3.4 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a sealable polyethylene bag. Note in a field notebook or on a standardized data sheet any changes in the color, texture or odor of the soil.

3.5 Thoroughly homogenize the sample material and write sample ID, date, and time on the bag with an indelible marker.

3.6 Complete required information on the Soil Sample Log Sheet (copy attached at the end of this SOP). Update the Chain-of-Custody (COC) Form.

3.7 Excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water.

3.8 Decontaminate all soil sampling equipment in accordance with SOP-06 before collecting the next sample.

3.9 Soil samples shipped to a fixed-base laboratory for analysis will be in sample containers supplied by the laboratory. The sample labels will be completed and affixed to the sample container. The samples will then be packaged and shipped to the fixed-base laboratory in accordance with SOP-05.

4.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: ____________________
[] QA Sample Type: ____________________

Sample ID No.: ____________________
Sample Location: ____________________
Sampled By: ____________________
C.O.C. No.: ____________________

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
SOP-08

SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil samples.

2.0 FIELD FORMS AND EQUIPMENT

Knife
Ruler (marked in tenths and hundredths of feet)
Boring Log: An example of this form is attached.
Writing utensil (preferably black pen with indelible ink)

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all activities and assuring that each soil sample is properly and completely logged.

4.0 PROCEDURES FOR SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are non-cohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist.
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb.
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail.
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

4.4 Weight Percentages

In nature, soils are consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., sandy)	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	inorganic clays of high plasticity, fat clays.
	OH	organic clays of medium to high plasticity, organic silts.
Silt	ML	inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity.
	OL	organic silts and organic silty clays of low plasticity.
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils.
Sand	SW	well graded sands, gravelly sands, little or no fines.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
	SP	poorly graded sands, gravelly sands, little or no fines.
	SM	silty sands, sand-silt mixtures.
	SC	clayey sands, sand-clay mixtures.

4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

5.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

ATTACHMENT 1

FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

Unified Soil Classification System

Coarse Grained Soils (more than half of soil > No. 200 sieve)	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Sandy gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
Fine Grained Soils (more than half of soil < No. 200 sieve)	Silts and Clays LL = < 50	ML	Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts
		CH	Inorganic silts of high plasticity, fat clays
		OH	Organic clays of high plasticity, organic silty clays, organic silts
Highly Organic Soils		Pt	Peat and other highly organic soils

Grain Size Chart

Classification	Range of Grain Sizes: U.S. Standard Sieve Size	Range of Grain Sizes: Grain Size In Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 4.76
fine	3/4" to No.4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No.4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Relative Density (SPT)

SANDS AND GRAVELS	BLOWS/FOOT
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	32 – 50
VERY DENSE	OVER 50

Consistency (SPT)

SILTS AND CLAYS	BLOWS/FOOT
VERY SOFT	0 – 2
SOFT	2 – 4
MEDIUM STIFF	4 – 8
STIFF	8 – 16
VERY STIFF	16 – 22
HARD	OVER 32

ATTACHMENT 2

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: ____________ BORING No.: ____________
PROJECT NUMBER: ____________ DATE: ____________
DRILLING COMPANY: ____________ GEOLOGIST: ____________
DRILLING RIG: ____________ DRILLER: ____________

					MATERIAL DESCRIPTION					PID/FID Reading (ppm)			
Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ____________

Drilling Area
Background (ppm): ____

Converted to Well: Yes ______ No ______ Well I.D. #: ____________

STANDARD OPERATING PROCEDURE

SOP-09

SEDIMENT SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling in streams and other waterways.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

Sediment Sample Log Forms: A copy of this form is attached at the end of this SOP.
Writing utensil (preferably black pen with indelible ink)
Indelible marker
Bound field logbook
Disposable plastic trowels
Survey stakes and flagging: Used to mark sampling locations after completion of sampling.
Labeled sample containers: See SOP-02 for sample identification procedures. Sample containers are certified clean by the laboratory supplying the containers.
Sealable polyethylene bags
Shipping containers (containing ice)
Disposable medical-grade gloves (e.g., latex, nitrile)
Chain-of-Custody Form

3.0 SEDIMENT SAMPLE LOCATION SELECTION

In general, sediments composed of fine-grained materials with greater surface area available for adsorption are more desirable for sample selection. The fined-grained materials may act as a sink or reservoir for adsorbing heavy metals and organic contaminants even if surface runoff concentrations are below detection limits. Therefore, it is important to locate the specific sampling points where the sediment has the greatest percentage of fine particles. The sampling personnel will determine specific sampling locations with these goals in mind.

4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The sampler will wear clean, disposable medical-grade gloves. Clear vegetative matter or debris, if present, from the sample location using a disposable sampling trowel or spoon. Use the trowel to dig up and homogenize the sediment in an 18-inch-diameter circular area that is 6 inches deep. Stir the sediment within the circular area; do not move the sediment outside the circle. Also, do not dig or stir sediment that is deeper than 6 inches below the ground surface, until the next depth interval is sampled.

- Use the same trowel to scoop the homogenized sediment into the requisite labeled sample container(s).

4.2 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels. Record all other information required on the labels as specified by SOP-02.

4.3 Place the labeled sample container into a sealable polyethylene bag and then place the bag holding the sample container into a cooler containing ice.

4.4 Record date, sampling site, site conditions, location map, and other information (e.g., presence and flow rate of water in channel) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody Form in accordance with SOP-04.

4.5 Using an indelible marker, write the sample identification on a survey stake, and drive the stake into the ground at the sample location. Tack a piece of brightly colored flagging to the stake. In addition, tie a piece of flagging to an overhead tree branch or other eye-level object to improve the ability to relocate the sampling site in the future.

5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ______________________
Project No.: ______________________

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: ______________________
[] QA Sample Type: ______________________

Sample ID No.: ______________________
Sample Location: ______________________
Sampled By: ______________________
C.O.C. No.: ______________________

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date:			
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date:				
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
SOP-10

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at Naval Support Activity (NSA) Crane. The following types of IDW will be generated during this investigation:

- Soil sampling residues
- Monitoring well development and well purge waters
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)
Hand augers, plastic or stainless steel trowels
Bucket (with collected development/purge water)
Decontamination equipment
Field logbook
Writing utensil (preferably black pen with indelible ink)
Plastic sheeting and/or tarps
55-gallon drums with sealable lids
IDW labels for drums
Plastic garbage bags

3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities if necessary.

3.1 Liquid Wastes

Liquid wastes that will be generated during the site activities include decontamination solutions from sampling equipment. These wastes will be collected and containerized in a central location at NSA Crane for proper disposal.

3.2 Solid Wastes

Solid wastes that may be generated during site activities include soil and sediment sampling residues. Excess soil core/sampling materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water. Excess sediment sampling materials will be returned to the point of collection. The disposition of this materials will be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

3.3 PPE and Incidental Trash

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

STANDARD OPERATING PROCEDURE

SOP-11

SUBSURFACE SOIL AND GROUNDWATER SAMPLING USING DIRECT-PUSH TECHNOLOGY

1.0 PURPOSE

This procedure provides general guidance and reference information on direct-push technology (DPT). DPT is designed to collect soil and groundwater samples without using conventional drilling techniques. The advantage of using DPT over conventional drilling includes the generation of little or no drill cuttings, ability to sample in locations with difficult accessibility, reduced overhead clearance requirements, no fluid introduction during probing, and typical lower costs per sample than with conventional techniques. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils (although it may be as much as 60 to 80 feet in certain types of geological environments), reduced capability of obtaining accurate water-level measurements, and the inability to install permanent groundwater monitoring wells.

The methods described herein are specific for soil, groundwater, and soil gas samples at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 (Water Well Drillers) of Chapter 310 of the Indiana Administrative Code (310 IAC 16) should be consulted.

2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction.

Field Geologist - The Tetra Tech Field Geologist supervises and documents DPT activity performed by the driller, and insures that the soil and groundwater samples collected accurately representative the desired media and sample interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

All Field Personal – All field personal including, the drilling contractor personnel and other field staff, must have all of the health and safety training required to perform the work, as specified in the Health and

Safety Plan (HASP). All field personnel shall be aware of the potential presence of underground utilities. Proper utility clearance must be obtained by the Tetra Tech Project Manager (PM) prior to any DPT activity.

If the potential of Unexploded Ordnance (UXO) is present at the site, UXO clearance to six feet will be required for subsurface samples. Every two feet the drill rig shall be withdrawn and a downhole magnetometer used to check for UXO. If the presence of any UXO is suspected, the drilling location will be shifted two feet and drilling resumed. A trained UXO technician will be part of the Tetra Tech field team.

3.0 REQUIRED EQUIPMENT/ITEMS

The list of equipment and items required for DPT sampling includes, but is not limited to:

Health and safety equipment as required by the HASP and the Site Safety Officer.

DPT Rig is supplied by the drilling subcontractor and may include the following:

- 4-foot x 2-inch diameter macrocore sampler
- Probe sampling adapters
- Disposable acetate liners for soil macrocore sampler
- Cast aluminum or steel drive points
- Geoprobe® AT-660 Series Large Bore Soil Sampler, or equivalent
- Stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent)

55-gallon drums to containerize IDW (supplied by the drilling subcontractor).

Required decontamination materials including distilled water, deionized water, paper towels, and stainless steel clamps.

Writing utensil (preferably black ink), non-latex gloves, bound field logbook, chain-of-custody forms, sample labels, boring log, sample logsheets, engineer's tape (or equivalent), and stainless-steel spoon or trowel.

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory. Additional sampling equipment as needed, such as photo-ionization detector (PID), flame-ionization detector (FID), Ziplock bags, calculator, wristwatch, and timer, and cooler (containing ice), peristaltic pump, inertial lift pump, silicon tubing, polyethylene (PE) tubing, water quality meter with a flow through cell, LaMotte 2020 Turbidity Meter (or equivalent), water level indicator, 0.45 micron filter cartridge, trip blanks, and bucket to collect development/purge water.

4.0 GLOSSARY

Direct Push Technologies (DPT) -DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools.

Geoprobe® is a manufacturer of a hydraulically-powered, percussion/probing machines utilizing DPT to collect subsurface environmental samples. Geoprobe® relies on a relatively small amount of static weight (vehicle) combined with percussion as the energy for advancement of a tool string. The Geoprobe® equipment can be mounted in a multitude of vehicles for access to all types of environmental sites.

HydroPunch™ is a manufacturer of stainless steel and Teflon® sampling tools that are capable of collecting representative groundwater and/or soil samples without requiring the installation of a groundwater monitoring well or conventional soil boring. HydroPunch™ is an example of DPT sampling equipment.

Flame Ionization Detector (FID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing a flame as the energizing source.

Photoionization Detector (PID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing ultraviolet radiation as the energizing source.

5.0 DPT SOIL SAMPLING PROCEDURES

General

The common methodology for the investigation of the vadose zone is soil boring drilling and soil sampling. However, drilling soil borings can be very expensive. Generally the advantage of DPT for subsurface soil sampling is the reduced cost of disposal of drilling cuttings and shorter sampling times.

DPT Sampling Methodologies

There are several methods for the collection of soil samples using DPT drilling. The most common method is discussed in the following section. Variations of the following method may be conducted upon approval of the Tetra Tech PM in accordance with the project-specific plan.

Macrocore samplers fitted with detachable aluminum or steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch diameter hole through the surface material. A Roto-hammer may also be used if very dense soils are encountered.

The sampler is advanced continuously in 4-foot intervals, or less if desired. No soil cuttings are generated because the soil which is not collected in the sampler is displaced within the formation.

The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an inner acetate liner.

- Attach the metal trough from the Geoprobe® Sampling Kit (or equivalent) firmly to the tail gate of a vehicle. If a vehicle with a tail gate is not available, secure the trough on another suitable surface.
- Place the acetate liner containing the soils in the trough.
- While wearing cut-resistant gloves (constructed of leather or other suitable material), cut the acetate liner through its entire length using the double-bladed knife. Then remove the strip of acetate from the trough to gain access to the collected soils. **Do not** attempt to cut the acetate liner while holding it in your hand.
- Field screen the sample with an FID or PID (according to manufacturer's Standard Operating Procedure [SOP]) and observe/examine the sample. If appropriate, transfer the sample to sample bottles for laboratory analysis. If additional volume is required, push an additional boring adjacent to the first and composite/mix the same interval. Field compositing is usually not acceptable for sample requiring volatile organic compounds (VOCs) analysis.
- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes should be finished smooth to existing grade.
- In the event the direct push van, truck, or track mounted rig cannot be driven to a remote location or a sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric operated equipment (e.g., jack hammer).
- Sampling equipment is decontaminated prior to collecting the next sample.

6.0 GROUNDWATER SAMPLING PROCEDURES

The most common methodology for the investigation of groundwater is the installation and sampling of permanent monitoring wells. If only groundwater screening is required, the installation and sampling of temporary well points may be performed. The advantage of temporary well point installation using DPT is reduced cost due to no or minimal disposal of drilling cuttings and well construction materials, and shorter installation/times sampling. Two disadvantages of DPT drilling for well point installation are:

- In aquifers with low yields, well points may have to be sampled without purging or development.
- If volume requirements are high, this method can be time consuming for low yield aquifers.

6.1 Sampling Equipment

Equipment needed for temporary well installation and sampling using DPT includes, but is not limited to the following:

- 2-foot x 1 -inch diameter mill-slotted (0.005 to 0.02-inch) well point Connecting rods
- Roto-hammer with 1.5-inch bit Mechanical jack
- 1/4-inch outside diameter (OD) PE tubing
- 3/8-inch OD PE tubing
- Peristaltic pump
- Standard decontamination equipment and solutions

6.2 DPT Sampling Methodologies

Once the water table has been encountered, a stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent) will be driven by DPT to collect a groundwater sample at the water table.

- Field screening of VOC vapors in the borehole shall be done using a FID or PID.
- The screen point will be allowed to equilibrate for at least 15 minutes.
- Once equilibration occurs, measurement of the static water level will be taken. This initial water level measurement will be used to assess the amount of water present in the screen point and to determine the amount of silt and/or sand infiltration.
- Development of the screen point will be accomplished using a peristaltic pump.

- Insert the intake end of a length of dedicated PE tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the PE tubing. The silicon tubing will be threaded around the rotor of the pump and out of the pump.
- The PE tubing will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development; however the yield of the formation will dictate the pumping rate.
- Measurement of pH, specific conductance, turbidity, dissolved oxygen, eH, salinity, and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell, with the exception of turbidity. Turbidity measurements will be taken with a Lamotte Turbidity Meter from water collected from a T-connector with a valve inserted in the pump discharge tubing prior to entering the flow-through cell.
- After removal of sediment from the bottom of the screen point, the screen point will be pumped until discharge water is visibly clear and no further sediments are being generated.
- Stabilization is achieved after two consecutive readings taken at 5 to 10 minutes intervals of the following field parameters has occurred:

    - pH +/- 0.1 standard units
    - Turbidity +/- 10% for values greater than 1 NTU
    - Specific conductance +/- 3%
    - Temperature +/- 3%
    - eH +/- 10 millivolts
    - Dissolved oxygen +/- 10%

- Samples will be collected using the peristaltic pump set at 0.2 liters per minute or lower, depending on the yield of the formation. Samples (with the exception of samples to be analyzed for VOCs) will be collected directly from the pump discharge. The pump shall continuously operate between development, purging, and sampling.

- If the above condition(s) have not been met after three well volumes have been removed, this will be recorded on the field sample form and the groundwater sample will be collected.

- Record the sample date and time (using military time) on a Tetra Tech Groundwater Sample Log Sheet and on a chain-of-custody form.

- Record the sample date and time (using military time) on an adhesive-backed sample label and affix the sample label securely to the sample container.

- With the pump continuing to run, allow the pump discharge to flow gently down the inside of the sample container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

- Cap each container immediately after filling.

- Place the sample container into a ziplock bag and then into a cooler containing ice.

- Repeat the last four steps for each sample container collected.

- The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Tetra Tech Groundwater Sample Log Sheet.

- All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. The hierarchy of filling sample containers is as follows:

  - VOCs
  - Explosives
  - Total metals
  - Dissolved metals
  - Perchlorates

- This hierarchy takes into consideration the volatilization sensitivity of groundwater samples. The only deviation from this order will be the collection of samples for VOC analysis. The collection of VOCs will be the final parameter collected due to the fact that VOCs will not be collected using the peristaltic pump.

- A single-use, disposable, in-line 0.45-micron filter cartridge shall be used to collect dissolved metals samples. Attach the filter cartridge to the discharge end of the pump tubing. Prior to filling containers with filtered sample, rinse the filter cartridge with approximately 100 milliliters (mL) of water from the boring to be sampled. Direct the discharge from the filter cartridge into the sample bottle and collect the filtered sample. The laboratory will supply all sample containers, and the laboratory will pre-preserve sample containers where appropriate.

- Once all of the sample containers have been filled (with the exception of those sample containers for VOC analysis), the pump shall be shut off. Record the sample date and time (in military time) on an adhesive-backed sample label and affix the sample label securely to the sample container. Sample containers for VOCs will be filled by crimping the discharge end of the PE tubing (immediately after shutting off the pump). Remove the inlet end of the PE tubing from the well, suspend the inlet tubing above the VOC sample container (pre-preserved 40 mL vial), and slowly allow water to fill each VOC sample container by gravity flow. The discharge of sample from the PE tubing shall be accomplished in a manner that allows the water to gently flow down the inside of the sample container. Sample containers for VOCs must be completely filled so that no headspace exists in the container. Record the end time for sampling on a Tetra Tech Groundwater Sample Log Sheet.

- Once collection of samples is complete, the driller shall remove the screen point and the screen point will be decontaminated in accordance with the procedures outlined in the decontamination SOP.

- If needed, continuous soil and groundwater sampling using DPT below the water table shall be done in accordance with those procedures outlined above.

- After the groundwater samples have been collected, the driller shall retract the screen point sampler from the borehole and proceed to abandon the borehole with a grout pump using a cement bentonite grout mix from the bottom up to the ground surface.

- When advancing a boring using DPT and refusal is encountered, the boring shall be deemed complete, drilling shall cease, and the borehole shall be abandoned with a grout pump using a cement bentonite grout mixture.

STANDARD OPERATING PROCEDURE
SOP-12

MONITORING WELL INSTALLATION

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper design and installation of ground water monitoring wells. The methods described herein are specific for monitoring well construction at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command, (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) should be consulted.

2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The drilling contractor personnel must have all of the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP).

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller, and insures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the Site Safety Officer.

Well drilling and installation equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, boring logs, soil sample log forms, chain-of-custody records, sample coolers with ice, and a field notebook).

4.0 WELL DESIGN AND CONSTRUCTION

New wells will be installed only with Navy concurrence. Based on observations and information gathered during the drilling of each hole, the total depth of the hole and the placement of the well screen will be determined at the discretion of the field geologist or the Field Operations Leader (FOL). The decision concerning the monitored interval and well depth will be based on the following (and possibly other) information collected while the well bore is being drilled and logged:

- The specific depths where poorly-cemented sandstone units, fractured rock, or other permeable rock zones are encountered,
- The specific depths where above-average rates of ground water were brought to the surface during drilling,
- The specific depth interval where contaminants (i.e., VOCs), if any, are encountered during drilling.

All of this information will be recorded on the borehole log as the hole is drilled.

Overburden drilling followed by diamond coring (if necessary) will be performed at borehole locations. For each well, the coring will proceed to the final depth of the borehole. Once the coring has been completed and the core has been logged, then the hole will be reamed out with a 6 to 8-inch diameter air rotary bit. The air rotary equipment must have a filter on the compressed air line going to the borehole to prevent oil and other organics from being introduced. Once the hole has been completed to depth, the boring shall be cleaned out using the compressed air of the rig. Note: all drilling equipment must be decontaminated before it is placed in a borehole.

A 6-inch diameter steel isolation casing will be installed and pressure grouted in the deep wells to seal the upper groundwater from deep groundwater. The grout will be allowed to cure for a minimum of 24 hours before resuming coring and reaming to the total depth of the borehole.

All monitoring wells will be constructed of schedule-40, flush-joint threaded, 2-inch inside diameter (ID) polyvinyl chloride (PVC) riser pipe and flush joint threaded, factory slotted well screen with a threaded end cap. The well screens will be factory slotted to 0.020-inch size. Each section of well casing and screen shall be National Sanitation Foundation (NSF) approved. Well screens will be 10-feet long, but may be longer or shorter based on the subsurface conditions encountered. A PVC cap will be placed on the bottom and will also be flush-threaded. Thermoplastic pipe shall comply with ASTM F-480 (1981). Other means of joining casings using glue, gaskets, pop rivets or screws are not allowed. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material.

Monitoring wells will be installed immediately upon completion of drilling. A well screen section with bottom cap and the proper amount of riser pipe will be assembled and lowered down the borehole. Spacers may be used to ensure that the casing and screen are centered and are aligned straight. Clean silica sand pack will be installed through the borehole. The sand pack will be extended from 0.5 feet below the well screen to 2.0 feet above the top of the well screen. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used.

A minimum 2-foot thick bentonite pellet seal will be installed above the filter pack and allowed to hydrate as determined by field geologist before grout is added above the seal. Only 100-percent, certified pure, sodium bentonite will be used for well construction. The depths of backfill materials will be constantly monitored during well installation using a weighted stainless steel or fiberglass tape measure.

The remaining annulus above the hydrated bentonite seal will be backfilled to the surface using a tremie pipe, with a 20:1 cement/bentonite grout. A maximum of 10 gallons of water per 94-pound bag of Type-1 cement will be used. The grout mixture should be blended in an above-ground rigid container or mixer to produce a thick lump-free mixture.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging, and to provide a better seal. However, in shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

When the well is completed and grouted to the surface, a protective steel surface casing is placed over the top of the well. The finished well casing shall extend at least 2 ft above the ground level. This casing will have a cap that will be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the riser pipe and is set into the wet cement grout over the riser upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

Four barrier posts shall be placed at the corner of a 3 foot by 3 foot by 6 inch thick concrete pad located at the ground surface.

5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and a field logbook.

All installed wells must be registered with the NSA Crane Environmental Protection Department. The following information must be supplied to NSA Crane for each well as soon as this information is known:

- Tag number
- Installation Name (i.e., NSA Crane)
- Contract Task Order number (CTO F273)
- TtNUS project number
- Well identification number
- Date installed
- Installer (i.e., TtNUS)
- Total well depth
- Screened interval
- Elevation (Top of casing)
- Northing coordinate (ft)
- Easting coordinate (ft)
- Survey coordinate reference system
- Information point of contact.

6.0 ATTACHMENTS

1. Bedrock Monitoring Well Sheet
2. Overburden Monitoring Well Sheet

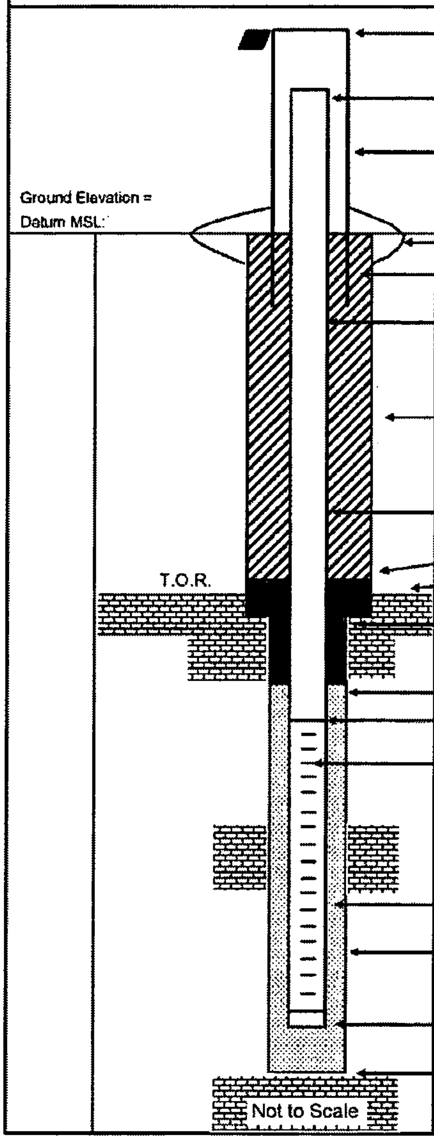
ATTACHMENT 1

BEDROCK MONITORING WELL SHEET

BEDROCK
MONITORING WELL SHEET

WELL No.: ____________
PERMIT No:

PROJECT:	____	DRILLING Co.:	____	BORING No.:	____
PROJECT No.:	____	DRILLER:	____	DATE COMPLETED:	____
SITE:	____	DRILLING METHOD:	____	NORTHING:	____
GEOLOGIST:	____	DEV. METHOD:	____	EASTING:	____



Elevation of Top of Casing: ____________

Stick Up of Casing Above Ground Surface: ____________
Elevation of Top of Riser: ____________

I.D. of Surface Casing: ____________

Type of Surface Casing: ____________

Type of Surface Seal: ____________
I.D. of Permanent Casing: ____________

I.D. of Riser: ____________

Type of Riser: ____________

Borehole Diameter: ____________

Type of Backfill: ____________

Elevation / Depth Top of Seal: ______ / ______
Elevation / Depth Top of Bedrock: ______ / ______

Type of Seal: ____________

Elevation / Depth of Top of Fine Sand: ______ / ______
Elevation / Depth of Top of Filter Pack: ______ / ______
Elevation / Depth of Top of Screen: ______ / ______

Type of Screen: ____________

Slot Size x Length: ____________

I.D. of Screen: ____________

Type of Filter Pack: ____________

Diameter of Hole in Bedrock:
Core / Ream: ____________

Elevation / Depth of Bottom of Screen: ______ / ______

Elevation / Total Depth of Borehole: ______ / ______

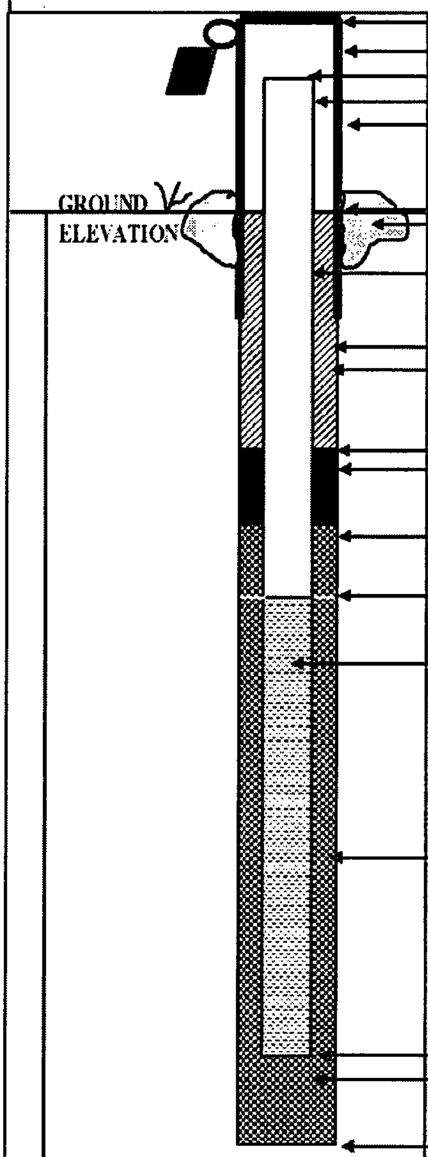
ATTACHMENT 2

OVERBURDEN MONITORING WELL SHEET

BORING NO.: ________

OVERBURDEN MONITORING WELL SHEET

PROJECT:	________	DRILLING Co.:	________	BORING No.:	________
PROJECT No.:	________	DRILLER:	________	DATE COMPLETED:	________
SITE:	________	DRILLING METHOD:	________	NORTHING:	________
GEOLOGIST:	________	DEV. METHOD:	________	EASTING:	________



ELEVATION OF TOP OF SURFACE CASING: ________
STICK -UP TOP OF SURFACE CASING: ________
ELEVATION OF TOP OF RISER PIPE: ________
RISER STICK-UP ABOVE GROUND SURFACE: ________
I.D. OF SURFACE CASING: ________
TYPE OF SURFACE CASING: ________
____
GROUND ELEVATION: ________
TYPE OF SURFACE SEAL: ________
____
RISER PIPE I.D.: ________
TYPE OF RISER PIPE: ________
BOREHOLE DIAMETER: ________
TYPE OF SEAL: ________
____
ELEVATION / DEPTH OF SEAL: ____ / ____
TYPE OF SEAL: ________
____
ELEVATION / DEPTH TOP OF FILTER PACK: ____ / ____
ELEVATION / DEPTH TOP OF SCREEN: ____ / ____
TYPE OF SCREEN: ________
SLOT SIZE X LENGTH: ________
I.D. OF SCREEN: ________
TYPE OF FILTER PACK: ________
____
ELEVATION / DEPTH BOTTOM OF SCREEN: ____ / ____
ELEVATION / DEPTH BOTTOM OF FILTER PACK: ____ / ____
TYPE OF BACKFILL BELOW WELL: ________
ELEVATION / DEPTH OF BOREHOLE: ____ / ____

STANDARD OPERATING PROCEDURE
SOP-13

MONITORING WELL DEVELOPMENT

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper development of new and existing monitoring wells. The methods described herein are specific for monitoring wells located at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command, (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) should be consulted.

2.0 RESPONSIBILITIES

The drilling contractor will provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing the development of monitoring wells. The drilling contractor personnel must have all of the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP).

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the Site Safety Officer.

Well development equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).

4.0 WELL DEVELOPMENT METHODS

The development of new wells shall not occur until at least 24 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Sequential measurements of pH, specific conductance, turbidity, and temperature will be taken during development. Development should proceed until criteria are met as stated in Navy Guidelines.

Vigorous on-and-off pumping or a surge block will be used for development.

A surge block that is approximately the same diameter as the well riser will be used to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. Site-specific conditions will dictate which type will be used. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Development should proceed until three consecutive pH, specific conductance, and temperature readings are within 10 percent of each other and three consecutive turbidity readings are within 5 Nephelometric Turbidity Units (NTUs) of each other. If these criteria cannot be met after five volumes of water have been removed, then one additional well volume will be removed and well development will be considered complete.

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the TtNUS Project Manager (PM) regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for that new environment to re-stabilize after the disturbance of drilling.

5.0 ATTACHMENTS

1. Monitoring Well Development Record

ATTACHMENT 1

MONITORING WELL DEVELOPMENT RECORD

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ____

Well: ______________________ Depth to Bottom (ft.): ______________ Responsible Personnel: ____________________________
Site: ______________________ Static Water Level Before (ft.): _______ Drilling Co.: ____________________________________
Date Installed: ______________ Static Water Level After (ft.): ________ Project Name: ___________________________________
Date Developed: _____________ Screen Length (ft.): _______________ Project Number: __________________________________
Dev. Method: ________________ Specific Capacity: _______________
Pump Type: _________________ Casing ID (in.): __________________

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units ____)	Turbidity (NTU)	Remarks (odor, color, etc.)

STANDARD OPERATING PROCEDURE
SOP-14

MEASUREMENT OF WATER LEVELS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

Ground Water Level Measurement Form: A copy of the Ground Water Level Measurement Form is attached.
Bound Field Log Book
Photoionization Detector (PID)
Well Key
Electronic Water-Level Indicator: The water level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 feet.
Decontamination Supplies

3.0 WATER-LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water level indicator or interface meter.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Check the well for the presence of organic vapors in the 2-inch PVC riser pipe as follows:

1. Calibration of the PID shall be done in accordance with appropriate calibration procedures.

2. Insert the PID sample inlet straw approximately three inches into the riser pipe.

3. Record the PID reading on the Ground Water Level Measurement Form. If the reading is less than concentrations specified in the site-specific Health and Safety Plan (HASP), proceed to step 3.6. If the reading is greater than the concentration specified in the HASP, measure the concentration in the breathing zone. If the concentration in the breathing zone is less than the concentration specified in the HASP, proceed to Step 3.6. If the reading is greater than the specified concentration, allow the riser pipe to ventilate for ten minutes and repeat the measurement of breathing zone concentrations until the concentrations fall below the level specified in the HASP before proceeding to step 3.6.

3.6 Ensure that the water level indicator probe has been decontaminated before use.

3.7 Slowly lower the probe into the well riser pipe (or into the surface water for staff gages) until an audible and/or visible signal is produced, indicating contact with the water surface.

3.8 Read the water level measurement from the top of the inner casing (or from the staff gage reference point) at the surveyed reference point to the nearest 0.01-foot.

3.9 Record the water level measurement on the Water Level Measurement Form.

3.10 Wind the meter cable measuring tape back onto the spool.

3.11 Replace the well cap and lock.

3.12 Decontaminate the meter's probe and cable.

4.0 ATTACHMENTS

1. Water Level Measurement Sheet

ATTACHMENT 1

WATER LEVEL MEASUREMENT SHEET

WATER LEVEL MEASUREMENT SHEET

Project Name: ____________ Project No.: ____________
Location: ____________ Personnel: ____________
Weather Conditions: ____________ Measuring Device: ____________
Tidally Influenced: Yes ___ No ___ Remarks: ____________

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

STANDARD OPERATING PROCEDURE

SOP-15

LOW-FLOW WELL PURGING AND STABILIZATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

Low-Flow Purge Data Sheet: A copy of this form is attached at the end of this SOP.
Ground Water Sample Log Sheet: A copy of this form and instructions for its completion are included in SOP-16.
Bound Field Log Book
Well key
Electronic water level indicator: The water level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01-feet.
Electronic Programmable Controller, model 400 or comparable: This controller regulates air flow in a bladder pump.
Cylinder of compressed nitrogen with regulator: Compressed gas serves as the power source for the bladder pump.
Multiple parameter water quality meter: This unit measures and displays field parameters measured in the field including pH, dissolved oxygen, oxidation-reduction potential (ORP), temperature, and specific conductance.
Flow-through cell adapter for water quality meter
LaMotte Turbidity Meter or comparable: Used to measure turbidity.
Purge water containers
Graduated cylinder and stopwatch: Used to calculate flow rate.

3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate as per manufacturer requirements above equipment as necessary.

3.2 Obtain a static water level measurement of the well to be purged. Record the information on the Ground Water Sample Log Sheet and the Low-Flow Purge Data Sheet. Leave the water level meter suspended in the well casing.

3.3 Calculate one well casing volume as follows:

1. Obtain the total depth of the well.

2. Using the static water level determined in Step 3.2 of this SOP and the total depth of the well, calculate the well casing volume using the following formula:

$$V = (0.163)(T)(r^2)$$

where:

V	=	Static casing volume of well (in gallons).
T	=	Vertical height of water column (linear feet of water).
0.163	=	A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.
r	=	Inside radius of the well casing (in inches).

Note: For wells of 1-inch radius (2-inch diameter) V = 0.163 gallons per foot of water column.

3.4 Connect the pump controller to the well pump air supply (at the well cap) by following the instructions in the pump control manual. The pump controller must be turned off when being connected.

3.5 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (PSI) when being connected.

3.6 Following the instructions found in the water quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).

3.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge-water container.

3.8 Following the instructions in the pump controller manual, start pumping water from the well.

3.9 Start with the initial pump rate set at approximately 0.1 liters/minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 feet during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 Nephelometric Turbidity Units (NTUs) after all other field parameters have stabilized. If ground water is drawn down below the top of the well screen, purging will cease and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same 8-hour workday and no later than 24 hours after the start of purging.

The time to sample any given well will vary greatly due to the many variables associated with low flow purging and sampling, such as:

- Stabilization of parameters
- Possible draw down
- Analytical changes from quarter to quarter
- Varying QA sample requirements from quarter to quarter
- Variable pump rates

Normally, the time from the start of purging to the end of sampling will be between 1 to 4 hours.

3.10 Measure the well water level using the water level meter every five to ten minutes. Record the well water level on the Low-Flow Purge Data Form (attached at the end of this SOP).

3.11 Record on the Low-Flow Purge Data Form every five to ten minutes the water quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, and dissolved oxygen) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

3.12 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

3.13 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

3.14 Stabilization is achieved and sampling can begin when a minimum of one casing volume has been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits:

pH ± 0.1 standard units
Specific conductance ± 3%
Temperature ± 1.0 °C
Turbidity less than 10 NTUs

If the above conditions have still not been met after the well has been purged for four hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data From onto the Ground Water Sample Log Form.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear line of sight to the well, the sampler may leave the pump running and watch the well until the sampler is able to return to the well.

- Two, if for whatever reason, the sampler must stop purging for an extended period of time or a clear line of sight cannot be maintained, the pump and cell will be shut-down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before departing.

In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Form.

3.15 Once sampling activities have been completed, turn the pump off. Remove pump, hoses, cables, and other equipment from the well.

3.16 Decontaminate pumps, hoses, cables, flow-through cell, and other equipment.

4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

ATTACHMENT 1
LOW-FLOW PURGE DATA SHEET

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: ____________________ WELL ID.: ____________________
PROJECT NUMBER: ____________________ DATE: ____________________

Time (Hrs.)	Water Level (Ft. below TOC)	Flow (mL/Min.)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celcius)	ORP mV	Comments

SIGNATURE(S): ______________________________ PAGE___OF___

STANDARD OPERATING PROCEDURE
SOP-16

MONITORING WELL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for monitoring well sampling. Low-flow sampling techniques will be used for ground water sampling at Naval Support Activity (NSA) Crane.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

Ground Water Sample Log Form: A copy of this form is attached at the end of this SOP.

Bound field log book

Chain-of-Custody Form

Bladder Pump

Surgical Gloves

Labeled sample containers: Sample containers are certified clean by the laboratory supplying the sample containers.

Tag for each sample container

Plastic storage bags

Shipping containers with ice

3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Ground water sampling may be initiated when the monitoring well has been purged and stabilized.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Sheet. Record the field measurements for pH, oxidation-reduction potential (ORP), specific conductance, temperature, dissolved oxygen, and turbidity.

3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.4 Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled. Sample containers for volatile organic compounds (VOCs) must be completely filled so that no headspace exists in the container. The VOC vials shall be filled to the top so that a convex meniscus is formed. Gently secure the cap, turn the vial upside down, and check to see if any air has been trapped inside the vial. If so, open the cap, reform the meniscus, and attempt again to secure the lid without trapping air in the sample. All other sample containers can have air space included when the container lid is secured.

3.5 Cap each container immediately after filling.

3.6 Record the sample time on the Ground Water Sample Log Form, the sample tag, and on the sample label.

3.7 Secure the associated tag to each sample container.

3.8 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.9 Enter the proper information on the Chain-of-Custody form for each sample container.

3.10 Repeat steps 3.3 through 3.9 for each sample container collected.

3.11 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Ground Water Sample Log Form.

3.12 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence (where applicable):

Volatile Organic Compounds (VOCs)
Appendix IX Metals

3.13 If the last turbidity measurement prior to the commencement of sampling showed turbidity to be greater than 5 Nephelometric Turbidity Units (NTUs), then filtered aliquots of ground water will be collected and analyzed for dissolved metals and dissolved thorium isotopes. Without turning off the pump, attach a disposable, inline, 0.45-um filter cartridge at the end of the discharge tube. Fill sample containers marked for "dissolved metals" so that the laboratory knows that these aliquots are distinct sample fractions and that the results should be reported as dissolved analytes. Samples scheduled for VOC analysis shall not be filtered.

3.14 Repeat steps 3.5 through 3.9 for the filtered sample containers.

3.15 After completion of sample collection, remove the bladder pump from well and decontaminate.

3.16 Replace the outer protective well cap and lock the well.

3.17 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves and other equipment should be placed in a plastic trash bag and handled as investigation derived waste.

4.0 ATTACHMENTS

1. Ground Water Sample Log Sheet

ATTACHMENT 1

GROUND WATER SAMPLE LOG SHEET

GROUND WATER SAMPLE LOG SHEET

Page ___ of ___

Project Site Name:	______	Sample ID No.:	______
Project No.:	______	Sample Location:	______
		Sampled By:	______
[] Domestic Well Data		C.O.C. No.:	______
[] Monitoring Well Data		Type of Sample:	
[] Other Well Type:	______	[] Low Concentration	
[] QA Sample Type:	______	[] High Concentration	

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	TBD	TBD
Time:	Visual	Standard	mS/cm	°C	NTU	mg/l		
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	TBD	TBD
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

TBD: To Be Determined

STANDARD OPERATING PROCEDURE

SOP-17

CALIBRATION AND CARE OF WATER QUALITY METERS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance. The YSI 600-Series Environmental Monitoring System or the Horiba U20–Series multi-parameter water quality monitoring system will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), and dissolved oxygen (DO) in water. A LaMotte turbidity meter will be used in conjunction with the water quality meter to measure turbidity. The water quality meter will have a multiprobe sensor that can be used in conjunction with a flow-through cell attached to a pump discharge tube to measure water-quality parameters in a ground water discharge or can be immersed in a surface water body such as a stream, pond, or drainage ditch. The LaMotte is a hand held meter that uses a multi-detector optical configuration to assure long term stability and minimize stray light and color interferences. All comparable equipment used in place of the equipment items identified in Section 2.0 below must be comparable in terms of sensitivity, accuracy, and precision.

2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

Site logbook
Equipment calibration log sheet
YSI Model 600 Series and Sonde or Horiba U20 Series, or comparable: multi-parameter water-quality meter with flow through cell.
LaMotte Turbidity Meter, or comparable
Equipment manual
Calibration kit
Deionized water, paper towels, spray bottle, etc.
Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES

This section describes the calibration procedures for the YSI Model 600 series, the Horiba U20 series, and the LaMotte. Each meter is supplied with an instruction manual and will be on site and will be used as the calibration guidance documents. These procedures will list requirements for frequency of calibration and checks to be performed on the meter.

3.1 YSI Model 600 Series and Horiba U20 Series

The YSI Model 600 series and Sonde and the Horiba U20 series are multi-parameter, water-quality meters that may be used to measure open water bodies (streams, ponds, springs, etc.) with the probe guard installed. With the flow through cell attached, the meters have the ability to measure water-quality parameters in ground water via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the ground water comes in contact with the atmosphere. The parameters measured by the YSI or the Horiba for this field effort are as follows:

- DO
- SC
- Temperature
- pH
- ORP
- Turbidity

3.1.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.1.2 Calibration

All the parameters listed in Section 3.0 must be calibrated prior to the start of each field effort. After this initial calibration, the meter will be checked each day that it is used. If the check shows any out-of-specification readings, the specific probe will be recalibrated. Meter specifications can be found in the equipment manual, starting on page 248 (YSI) or page 93 (Horiba). Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.1.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.
- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.
- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.
- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.
- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

3.2 Lamotte Turbidity Meter

The Lamotte turbidity meter is a hand held meter that measures the amount of suspended matter in water using the Nephelometric method.

3.2.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.2.2 Calibration

Turbidity must be calibrated prior to the start of each field effort. After this initial calibration, the LaMotte will be calibrated each day that it is used. If the check shows any out-of-specification readings, the meter will be recalibrated. Meter specifications can be found in the equipment manual. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.2.2 Tips for Good Calibration

- Thoroughly clean the standard vial with a chem wipe to remove finger prints.

- Make sure that the vial is properly aligned according the manual recommendations.

4.0 MAINTENANCE

The YSI and/or Horiba Meter and LaMotte will be rented for the duration of each brief field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

4.1 Meter Storage for the YSI and Horiba

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. During these breaks, the meter will be charged. One-half inch of tap or distilled water will be placed in the meter calibration cup and the cup threaded onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Multi-parameter short term storage key points:

- Use enough water to provide humidity but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, consult Section 2.10 on page 89 (YSI) or Section 7.1 on page 86 (Horiba) of the equipment manual.

Note: Reagents that are used to calibrate and check the water quality meter may be hazardous. Review the health and safety plan and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

4.3 Meter Storage for the LaMotte

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. Proper storage of the meter between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Short term storage key points:

- Make sure the storage vessel is moisture free and sealed.

4.4 Sample Vial Cleaning

- Rinse the vial thoroughly with potable water to remove sediments.
- Wipe with chem.-wipes or cotton swabs.

5.0 ATTACHMENTS

1. Equipment Calibration Log

ATTACHMENT 1

EQUIPMENT CALIBRATION LOG

EQUIPMENT CALIBRATION LOG

PROJECT NAME : ____________________ INSTRUMENT NAME/MODEL: ____________________

SITE NAME: ____________________ MANUFACTURER: ____________________

PROJECT No.: ____________________ SERIAL NUMBER: ____________________

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

STANDARD OPERATING PROCEDURE
SOP-18

SURFACE WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting surface water samples at the Naval Support Activity (NSA) Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Surface Water Sample Log Sheet: A copy of this form is attached at the end of this SOP.
Field logbook
Writing utensil
Multi-parameter water-quality meter: The water-quality meter is used for the measurement of dissolved oxygen, pH, specific conductance, temperature, and oxidation-reduction potential (see SOP-17).
LaMotte Turbidity Meter: Used to measure turbidity in the field (see SOP-17).
Disposable sample containers: Disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering.
Labeled sample containers: Prelabeled, certified-clean sample containers will be provided by the laboratory that performs the analyses.
0.45-micron filter assembly: These are single-use filter cartridges used to filter samples scheduled for dissolved metals analyses. The filters become investigation-derived waste (IDW) after one use.
Peristaltic pump
Silicon tubing
Ziploc-type plastic storage bags
Shipping containers (coolers)
Trip blank sample (if VOC samples are being collected)
Temperature blank

3.0 SURFACE WATER SAMPLING PROCEDURES

3.1 The same methods will be used to collect surface water and seep samples. Sampling will start at the downstream end of a stream and proceed to the farthest upstream location.

3.2 While standing downstream or from the bank, gently remove any floating leaves or twigs that may be present in a sample pool area in a manner that will not disturb the bottom sediment.

3.3 While standing downstream or from the bank, place the sample container in the water at the sampling location at a 45-degree angle and lower it to approximately half the sample pool depth. With the mouth of the container facing upstream, fill the container with water, being careful not to disturb the sediment.

3.4 All samples will be collected into certified-clean, pre-preserved bottles (if preservation is required for the analysis to be performed) supplied by the laboratory performing the analyses. Sample containers for volatile constituents (VOCs) must be completely filled so no headspace exists in the container. Other sample containers should not be filled completely; a small amount of air should be left at the top. Sample containers will be collected in the following sequence:

Volatile organic compounds (VOCs)
Other Organics
Total metals
Nitrate
Nitrite
Total suspended solids (TSS)
Dissolved metals

3.5 Record the date and time that the sample containers are filled on the Surface Water Sample Log Sheet, the sample labels, and the Chain-of-Custody Form.

3.6 After the sample label is completed and checked, place the sample container into a ziploc-type plastic storage bag and place the plastic storage bag holding the sample container into a cooler containing ice.

3.7 Repeat steps 3.3 through 3.6 until all the sample bottles containing unfiltered samples have been filled.

3.8 Fill two 1-liter unpreserved polyethylene bottles. Use these bottles to transfer the sample for field filtering. Set up a peristaltic pump for filtering of the dissolved metals samples. Using new, clean, disposable silicone tubing and a 0.45-micron filter, place the intake tubing from the pump into the transfer bottle with the filter attached to the discharge end and start the pump. Pre-rinse the filter with approximately 50 milliliters of sample water prior to filling the sample containers.

3.9 Using the discharge from the filter cartridge, fill one 1-liter polyethylene sample bottle for dissolved metals. Repeat steps 3.8 and 3.9 for these sample containers.

3.10 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential using the multi-parameter water-quality meter and LaMotte Turbidity Meter (see SOP-17). Record the readings in the appropriate fields on the Surface Water Sample Log Sheet.

3.11 Estimate the flow rate of the stream or spring. This is an estimate only. Round the flow rate to the nearest 5 gallons and record this number on the Surface Water Sample Log Sheet.

3.12 Decontaminate all equipment and load the equipment and the sample cooler in the sample vehicle for transport.

4.0 ATTACHMENTS

1. Surface Water Sample Log Sheet

ATTACHMENT 1

SURFACE WATER SAMPLE LOG SHEET

SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ______________ Sample ID No.: ______________
Project No.: ______________ Sample Location: ______________
Sampled By: ______________
C.O.C. No.: ______________

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: ______________
[] QA Sample Type: ______________

Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color Visual	pH Standard	S.C. mS/cm	Temp. Degrees C	Turbidity NTU	DO mg/l	Salinity %	ORP mV
Date:								
Time:								
Depth:								
Method:								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):